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**DELAYED NEUTRON STUDY
USING ENDF/B-VI
BASIC NUCLEAR DATA**

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The basic nuclear data of the latest releases of ENDF/B-VI were used in preliminary calculations with the CINDER'90 nuclide inventory code to simulate the activity of delayed-neutron precursors. Total delayed-neutron production was obtained at times during and following pulse (0.1-ms) and equilibrium (4-hr) fission histories for each of the sixty fission systems having fission-product yields in ENDF/B-VI.

The equilibrium studies — at unit fission rate for constant fission periods sufficiently long that all precursors are at saturation inventories — yielded the $\bar{\nu}_d$ value for each system. Delayed-neutron production rates at 54 decay times t , extending to 500 s following a fission pulse, were fit using the STEPIT code to the pulse function $R(t) = \sum a_i \lambda_i e^{-\lambda_i t}$. Results following equilibrium irradiations were fit to the equilibrium function $R(\infty, t) = \sum a_i e^{-\lambda_i t}$.

It was observed that functions from fits to pulse results did not well represent equilibrium results at long cooling times. Similarly, functions fit to the equilibrium results did not well represent pulse results at short cooling times. A comprehensive series of CINDER'90 calculations was made for irradiation times T of 0.1 ms, 1 s, 10 s, 100 s, 1000 s, and 4 hours; results were obtained at 60 decay times t extending to 800 s following irradiation. The body of results for each system was included in a fit to obtain the neutron production rate $R(T, t) = \sum a_i e^{-\lambda_i t} (1 - e^{-\lambda_i T})$ for each system. The resulting pulse functions $R(t)$, defined by the a_i and λ_i thus obtained, accurately represent calculated delayed-neutron production when integrated with any irradiation history.

The pulse functions thus produced and other published pulse functions fit to past measurements and calculations are compared numerically at several times after fission. Reactivity effects of all functions from measurements and calculations for each of the sixty systems are indicated by the asymptotic periods following positive 10¢ – 50¢ reactivity steps simulated in point-reactor kinetics calculations using the AIREK-10 code.

INTRODUCTION

The first release of ENDF/B-VI data (NNDC, 1989) in 1989 included nuclear data in a variety of areas — cross sections, decay data, fission-product yields, and others. Each of these is the product of one or more working groups concentrating on data evaluations in that area. Decay data, for example, encompasses half-lives, decay branchings, decay spectra, and average decay energies. Fission-product yield evaluations require decay data for the propagation of independent yields to form cumulative yields of each fission-product nuclide. Aggregate delayed-neutron data evaluations require yield and decay branching data to model the production and decay of precursors.

Each of these parallel evaluation efforts necessarily proceed without access to end products of the associated areas. Interim results from associated evaluation efforts are necessarily employed, leading to end products that are not wholly compatible and consistent. The problem is exacerbated with the subsequent release of modified evaluations, or “mods.” Such has been the environment for evaluations in all areas and all versions of ENDF/B.

Evaluations of data describing delayed-neutron production suffered somewhat from these limitations. The evaluation of delayed-neutron emission spectra and Pn branching fractions were completed well before the first release of ENDF/B-VI. These spectra were incorporated into the decay data of ENDF/B-VI, but the evaluated Pn values were only selectively used in the branching fractions of the decay data files. Aggregate delayed-neutron production rates extending to 300 s were obtained from summation calculations with the CINDER-10 code (England and Wilson, 1993), using decay and

fission-yield data available prior to the availability of the fifty yield sets released with ENDF/B-VI. Traditional fits of sums of six exponentials were made to these delayed-neutron production rates calculated with CINDER-10 for many of the fissioning systems.(Brady and England, 1989; Brady, 1989)

In the ensuing years the ENDF/B-VI 6-group fits have been found inadequate in many applications. Popular speculation was that the results to which fits were made should have extended to longer times, that the long-lived "group" 1 decay constant should be fixed at the value of the longest-lived precursor — 55.69 s ^{87}Br , and that six group fits in general may be inadequate for many applications. In 1993 a new evaluation of fission-product yields was completed for ENDF/B-VI and released;(England and Rider, 1994) the use of these yields, more than any other consideration, are thought responsible for present improvements in aggregate delayed-neutron production results and associated 6-group fits.

The following sections describe the present state of the applicable basic nuclear data of ENDF/B-VI, new summation calculations using these data, and the functions fit to the obtained results.

BASIC NUCLEAR DATA OF ENDF/B-VI

The present work concerns only the magnitude of delayed-neutron production and excludes concerns with the associated temporal neutron spectra. The CINDER'90 code (Wilson et al.,1995) has been used to simulate the nuclide inventory and associated delayed-neutron production in a fissioning sample. Nuclear data required for the calculation thus include fission-product yields and fission-product decay data — including Pn values. The CINDER'90 library includes all ENDF/B-VI fission-product decay branchings (England et al.,1989; England et al. 1993) and the Pn data of England and Brady.(England and Brady, 1988) Where the later differ from the Pn values of ENDF/B-VI, England and Brady data are used and the complementary branchings of ENDF/B-VI are adjusted to accommodate these data.

The yield sets of ENDF/B-VI('93) describe the distribution of fission yield for sixty fissioning systems — defined by the fissioning nuclide and specification of spontaneous fission or fission induced by incident thermal (.0253-eV), fast (\approx 500-keV), or high-energy (\approx 14-MeV) neutrons.(England and Rider, 1994) The sixty yield sets, included in the CINDER'90 library, describe the fission of 36 nuclides at one or more energies, as shown in Table 1. These are ordered for our purposes on Z,A, and fission energy.

Table 1. Identification of the Sixty ENDF/B-VI('93) Fission-Product Yield Sets

Fissioning Nuclide	SF	Thermal	Fast	HE	Fissioning Nuclide	SF	Thermal	Fast	HE
^{227}Th		1			^{241}Am		37	38	39
^{229}Th		2			^{242m}Am		40		
^{232}Th			3	4	^{243}Am			41	
^{231}Pa			5		^{242}Cm			42	
^{232}U		6			^{243}Cm		43	44	
^{233}U		7	8	9	^{244}Cm	45		46	
^{234}U			10	11	^{245}Cm		47		
^{235}U		12	13	14	^{246}Cm	48		49	
^{236}U			15	16	^{248}Cm	50		51	
^{237}U			17		^{249}Cf		52		
^{238}U	18		19	20	^{250}Cf	53		54	
^{237}Np		21	22	23	^{251}Cf				
^{238}Np			24		^{252}Cf	55			
^{238}Pu			25		^{253}Es	56			
^{239}Pu		26	27	28	^{254}Es		57		
^{240}Pu		29	30	31	^{254}Fm	58			
^{241}Pu		32	33		^{255}Fm			59	
^{242}Pu		34	35	36	^{256}Fm	60			

PRELIMINARY CALCULATIONS OF AGGREGATE DELAYED-NEUTRON PRODUCTION RATES

Calculations with CINDER'90 were made by first producing a modified version of its nuclear data library. A single fissioning nuclide (^{224}Ra) was selected. It was assigned a fictitious fission cross section of 1×10^4 barns in all energy

groups and given a non-physical atom density of 1×10^3 atoms/barn-cm. A 1×10^7 n/cm²-s flux of arbitrary spectrum was used to produce a fission rate of 1×10^{-10} fissions/s-barn-cm. The high cross-section and atom-density values resulted in a low flux, adequate fission rate, and the absence of significant target depletion or fission-product absorption during irradiation. The unique properties of each fissioning system were determined by the ENDF/B-VI fission yield set selected, requiring the modification of a single library record for each calculation. This is consistent with the procedure used in the earlier CINDER-10 calculations.

Two CINDER'90 calculations were made for each fissioning system. First, a four-hour fission history was calculated to obtain the equilibrium delayed-neutron production rate at a constant fission rate. The ratio of these two quantities is the number of delayed neutrons produced per fission — $\bar{\nu}_d$. The second calculation gave the delayed-neutron production following a 0.1-ms fission pulse at 54 decay times ranging from 0 to 500 s. The results of these calculations are given for ^{235}U thermal fission, as an example, in Table 2.

Table 2: Results of Preliminary CINDER90 Calculations of Delayed Neutron Production Following Equilibrium and Pulse Thermal Fissions of ^{235}U

Decay Time,s	Equilibrium, n/s per f/s	Pulse, n/s per f	Decay Time,s	Equilibrium, n/s per f/s	Pulse, n/s per f	Decay Time,s	Equilibrium, n/s per f/s	Pulse, n/s per f
0.00	1.67037E-02	9.49852E-03	2.00	9.51811E-03	1.74493E-03	40.00	1.30284E-03	3.64434E-05
0.01	1.66097E-02	9.29530E-03	2.50	8.72451E-03	1.44607E-03	45.00	1.13560E-03	3.06853E-05
0.03	1.64277E-02	8.91106E-03	3.00	8.05911E-03	1.22550E-03	50.00	9.94065E-04	2.60916E-05
0.05	1.62530E-02	8.55421E-03	3.50	7.49084E-03	1.05420E-03	60.00	7.69612E-04	1.92271E-05
0.07	1.60853E-02	8.22229E-03	4.00	6.99930E-03	9.16682E-04	70.00	6.02793E-04	1.44072E-05
0.10	1.58455E-02	7.76646E-03	4.50	6.57006E-03	8.03824E-04	80.00	4.77045E-04	1.09261E-05
0.15	1.54741E-02	7.10337E-03	5.00	6.19235E-03	7.09780E-04	90.00	3.81208E-04	8.37087E-06
0.20	1.51334E-02	6.54026E-03	6.00	5.55984E-03	5.63203E-04	100.00	3.07447E-04	6.47421E-06
0.30	1.45264E-02	5.64135E-03	7.00	5.05292E-03	4.56015E-04	110.00	2.50147E-04	5.05344E-06
0.40	1.39977E-02	4.96067E-03	8.00	4.63885E-03	3.75896E-04	120.00	2.05227E-04	3.98023E-06
0.50	1.35291E-02	4.42996E-03	9.00	4.29478E-03	3.14952E-04	150.00	1.18514E-04	2.04989E-06
0.60	1.31080E-02	4.00539E-03	10.00	4.00436E-03	2.67880E-04	200.00	5.32699E-05	7.94259E-07
0.70	1.27254E-02	3.65810E-03	12.00	3.53984E-03	2.01718E-04	250.00	2.61969E-05	3.56903E-07
0.80	1.23744E-02	3.36856E-03	15.00	3.03128E-03	1.43145E-04	300.00	1.34930E-05	1.75306E-07
0.90	1.20501E-02	3.12321E-03	20.00	2.45411E-03	9.40601E-05	350.00	7.10574E-06	9.02153E-08
1.00	1.17485E-02	2.91242E-03	25.00	2.05197E-03	6.91677E-05	400.00	3.78082E-06	4.74870E-08
1.20	1.12019E-02	2.56816E-03	30.00	1.74647E-03	5.41214E-05	450.00	2.02121E-06	2.52609E-08
1.50	1.04923E-02	2.18325E-03	35.00	1.50285E-03	4.39153E-05	500.00	1.08285E-06	1.35029E-08

The $\bar{\nu}_d$ values obtained from the Equilibrium CINDER'90 calculations (at 0 decay time) are compared in Table 3 with available evaluated $\bar{\nu}_d$ data sets and reference values considered representative of each system, where available. The reference values draw heavily from the ENDF/B-VI energy-dependent $\bar{\nu}_d$ evaluations summarized in Table 4, supplemented by data of JENDL3.2 (Shabita et al., 1990) and of Waldo, Karam and Meyer, '81. Table 5 accumulates reference $\bar{\nu}_t$ and $\bar{\nu}_d$ values for subsequent applications to be discussed.

Table 3. Comparison of $\bar{\nu}_d$ Data Sets

Fission System ^a	Delayed Neutrons per 100 Fissions					
	Present Work	Reference Values ^b	Brady & England, '89	Tuttle, '79	England et al., '83	England & Rider, '83
$^{227}\text{Th}(\text{T})$	0.62081	0.77 ^J	1.41 ± 0.26			1.41 ± 0.41
$^{229}\text{Th}(\text{T})$	1.14618	1.62 ^J	1.82 ± 0.29			1.81 ± 0.58
$^{232}\text{Th}(\text{F})$	6.30500	5.27	5.64 ± 0.41	5.31 ± 0.23	4.76 ± 0.34	5.69 ± 1.05
$^{232}\text{Th}(\text{H})$	6.00532	3.00	4.16 ± 0.36	2.85 ± 0.13	3.03 ± 0.29	4.16 ± 1.05
$^{231}\text{Pa}(\text{F})$	1.41744	1.60	1.60 ± 0.23	1.11 ± 0.11		1.60 ± 0.35
$^{232}\text{U}(\text{T})$	0.45655	0.44	0.52 ± 0.08			0.52 ± 0.09
$^{233}\text{U}(\text{T})$	0.75342	0.74	0.97 ± 0.16	0.67 ± 0.03	0.85 ± 0.07	0.96 ± 0.22
$^{233}\text{U}(\text{F})$	0.70515	0.74	0.90 ± 0.12	0.73 ± 0.04	0.92 ± 0.09	0.91 ± 0.15
$^{233}\text{U}(\text{H})$	0.75417	0.47	0.70 ± 0.10	0.42 ± 0.03	0.71 ± 0.10	0.70 ± 0.13
$^{234}\text{U}(\text{F})$	0.99175	1.29	1.29 ± 0.15	1.05 ± 0.11		1.30 ± 0.21
$^{234}\text{U}(\text{H})$	0.77725	0.77	0.77 ± 0.11	0.62 ± 0.08		0.76 ± 0.15
$^{235}\text{U}(\text{T})$	1.67037	1.67	1.78 ± 0.10	1.62 ± 0.05	1.77 ± 0.08	1.77 ± 0.14

Table 3. Comparison of $\bar{\nu}_d$ Data Sets (Continued)

Fission System ^a	Delayed Neutrons per 100 Fissions					
	Present Work	Reference Values ^b	Brady & England, '89	Tuttle, '79	England et al., '83	England & Rider, '83
$^{235}\text{U(F)}$	1.78770	1.67	2.06 ± 0.20	1.67 ± 0.04	1.98 ± 0.18	2.06 ± 0.27
$^{235}\text{U(H)}$	1.33576	0.90	1.09 ± 0.13	0.93 ± 0.03	0.98 ± 0.10	1.08 ± 0.18
$^{236}\text{U(F)}$	2.14612	2.32	2.32 ± 0.23	2.21 ± 0.24	2.21 ± 0.19	2.32 ± 0.31
$^{236}\text{U(H)}$	1.68239	1.55	1.55 ± 0.17	1.30 ± 0.20		1.54 ± 0.23
$^{237}\text{U(F)}$	2.97250	3.50	3.50 ± 0.28		3.50 ± 0.38	
$^{238}\text{U(S)}$	4.69491					
$^{238}\text{U(F)}$	4.19651	4.40	4.05 ± 0.29	4.39 ± 0.10	3.51 ± 0.27	3.54 ± 0.36
$^{238}\text{U(H)}$	2.84128	2.60	2.76 ± 0.25	2.73 ± 0.08	2.69 ± 0.21	2.71 ± 0.35
$^{237}\text{Np(T)}$	1.68208	1.08				
$^{237}\text{Np(F)}$	1.25427	1.08	1.14 ± 0.12		1.28 ± 0.13	1.14 ± 0.15
$^{237}\text{Np(H)}$	1.06341	0.65	0.97 ± 0.11		0.96 ± 0.13	
$^{238}\text{Np(F)}$	1.84597	2.16	2.16 ± 0.19		2.15 ± 0.24	
$^{238}\text{Pu(F)}$	0.64168	0.42	0.79 ± 0.09	0.47 ± 0.05		0.79 ± 0.11
$^{239}\text{Pu(T)}$	0.73726	0.65	0.76 ± 0.04	0.63 ± 0.04	0.77 ± 0.06	0.76 ± 0.05
$^{239}\text{Pu(F)}$	0.65491	0.65	0.68 ± 0.08	0.63 ± 0.02	0.72 ± 0.09	0.68 ± 0.09
$^{239}\text{Pu(H)}$	0.58384	0.43	0.38 ± 0.06	0.42 ± 0.02	0.39 ± 0.06	0.38 ± 0.07
$^{240}\text{Pu(T)}$	0.94423	0.90				
$^{240}\text{Pu(F)}$	0.90283	0.90	0.81 ± 0.09	0.95 ± 0.08	0.92 ± 0.11	0.81 ± 0.11
$^{240}\text{Pu(H)}$	0.72497	0.62	0.51 ± 0.07	0.67 ± 0.05		0.50 ± 0.09
$^{241}\text{Pu(T)}$	1.34008	1.62	1.41 ± 0.09	1.52 ± 0.11	1.58 ± 0.13	1.39 ± 0.12
$^{241}\text{Pu(F)}$	1.37910	1.62	1.42 ± 0.14	1.52 ± 0.11	1.49 ± 0.16	1.39 ± 0.16
$^{242}\text{Pu(T)}$	1.97081	1.97				
$^{242}\text{Pu(F)}$	1.76997	1.97	1.43 ± 0.14	2.21 ± 0.26	1.41 ± 0.14	1.40 ± 0.16
$^{242}\text{Pu(H)}$	1.68578	1.18				
$^{241}\text{Am(T)}$	0.58768	0.43	0.53 ± 0.07			0.53 ± 0.07
$^{241}\text{Am(F)}$	0.46476	0.43	0.51 ± 0.06			0.50 ± 0.07
$^{241}\text{Am(H)}$	0.40671	0.24	0.26 ± 0.05			0.25 ± 0.05
$^{242m}\text{Am(T)}$	0.78768	0.69	0.78 ± 0.09			0.76 ± 0.11
$^{243}\text{Am(F)}$	0.87615	0.80	0.80 ± 0.09			0.79 ± 0.10
$^{242}\text{Cm(F)}$	0.18564	0.14	0.14 ± 0.03			0.13 ± 0.03
$^{243}\text{Cm(T)}$	0.50110	0.30^J				
$^{243}\text{Cm(F)}$	0.30658	0.30^J				
$^{244}\text{Cm(S)}$	0.44492					
$^{244}\text{Cm(F)}$	0.49081	0.44^J				
$^{245}\text{Cm(T)}$	0.73828	0.59	0.64 ± 0.08			0.60 ± 0.09
$^{246}\text{Cm(S)}$	0.71116					
$^{246}\text{Cm(F)}$	1.10991	0.92^J				
$^{248}\text{Cm(S)}$	1.52465					
$^{248}\text{Cm(F)}$	2.12267	1.96^J				
$^{249}\text{Cf(T)}$	0.29367	0.27	0.16 ± 0.03			0.16 ± 0.03
$^{250}\text{Cf(S)}$	0.44107					
$^{251}\text{Cf(T)}$	0.83852	0.75	0.75 ± 0.08			0.73 ± 0.09
$^{252}\text{Cf(S)}$	0.73021	0.86^W	0.65 ± 0.07		0.69 ± 0.09	0.61 ± 0.07
$^{253}\text{Es(S)}$	0.33956					
$^{254}\text{Es(T)}$	0.78081	0.60^J	0.46 ± 0.06			0.39 ± 0.06
$^{254}\text{Fm(S)}$	0.14463					
$^{255}\text{Fm(T)}$	0.63568		0.28 ± 0.04			0.25 ± 0.04
$^{256}\text{Fm(S)}$	0.36334					

a In this table, T, F, H, and S denote thermal, fast, high energy, and spontaneous fission, respectively.

b Reference values are from ENDF/B-VI except, where noted, from (J) JENDL3.2 and (W) Waldo, Karam and Meyer, '81.

Table 4. ENDF/B-VI $\bar{\nu}_d$ Data for (n,f) Targets

Target Nuclide	ENDF/B-VI $\bar{\nu}_d$ Values (delayed neutrons per fission) at E_n for Linear–Linear Interpolation									
	10^{-5} eV	4 MeV	4.5 MeV	6 MeV	7 MeV	8 MeV	8 MeV	14 MeV	15 MeV	20 MeV
^{232}Th	0.0527	0.0527			0.03					0.03
^{231}Pa	0.01597319	0.01597319			0.009583913					0.009583913
^{232}U	0.00437	0.00437			0.002622					0.002622
^{233}U	0.0074			0.0074					0.0047	0.0042
^{234}U	0.0129	0.0129			0.00774					0.00774
^{235}U	0.0167	0.0167			0.0090					0.0090
^{236}U	0.0232	0.0232			0.0155					0.0155
^{237}U	0.03495967	0.03495967			0.02097580					0.02097580
^{238}U	0.044	0.044			0.006486				0.026	
^{237}Np	0.01081	0.01081			0.01293601					0.006486
^{238}Np	0.02156	0.02156			0.002436					0.01293601
^{238}Pu	0.00418	0.00418								0.002436
^{239}Pu	0.00645	0.00645			0.0043					0.0043
^{240}Pu	0.0090	0.0090			0.00615					0.00615
^{241}Pu	0.0162	0.0162			0.0084					0.0084
^{242}Pu	0.0197	0.0197			0.01182					0.01182
^{241}Am	0.00427	0.00427			0.002418					0.002418
^{242m}Am	0.0069	0.0069			0.00414					0.00414
^{243}Am	0.007951066	0.007951066			0.004770640					0.004770640
^{242}Cm	0.001360912	0.001360912			0.0008165473					0.0008165473
^{245}Cm	0.0059	0.0059			0.00354					0.00354
^{249}Bk	0.0089			0.0089		0.00162				0.0061
^{249}Cf	0.0027	0.0027			0.004518375					0.00162
^{251}Cf	0.007530626	0.007530626								0.004518375

Table 5. Reference $\bar{\nu}_d$ and $\bar{\nu}_t$ Values^a

System	$\bar{\nu}_d$	$\bar{\nu}_t$	System	$\bar{\nu}_d$	$\bar{\nu}_t$
$^{227}\text{Th(T)}$	.00769 ^J	2.0647 ^J	$^{240}\text{Pu(H)}$	.00615	4.928570
$^{229}\text{Th(T)}$	.01621 ^J	2.0872 ^J	$^{241}\text{Pu(T)}$	.0162	2.9453
$^{232}\text{Th(F)}$	.0527	2.0375	$^{241}\text{Pu(F)}$	.0162	2.9497
$^{232}\text{Th(H)}$	.0300	3.9409	$^{242}\text{Pu(T)}$	.0197	2.81
$^{231}\text{Pa(F)}$	0.01597319	2.376	$^{242}\text{Pu(F)}$	.0197	2.8888
$^{232}\text{U(T)}$	0.00437	3.13	$^{242}\text{Pu(H)}$	.01182	5.0155
$^{233}\text{U(T)}$	0.0074	2.4947	$^{241}\text{Am(T)}$	.00427	3.238788
$^{233}\text{U(F)}$	0.0074	2.5147	$^{241}\text{Am(F)}$	.00427	3.3062
$^{233}\text{U(H)}$	0.0047	4.2704	$^{241}\text{Am(H)}$	.002418	5.0590
$^{234}\text{U(F)}$	0.0129	2.4195	$^{242m}\text{Am(T)}$	.0069	3.264
$^{234}\text{U(H)}$	0.00774	4.242	$^{243}\text{Am(F)}$	.007951066	3.341871
$^{235}\text{U(T)}$	0.0167	2.4367	$^{242}\text{Cm(F)}$	.001360912	3.526
$^{235}\text{U(F)}$	0.0167	2.480825	$^{243}\text{Cm(T)}$	.00301 ^J	3.43
$^{235}\text{U(H)}$	.009	4.394742	$^{243}\text{Cm(F)}$	.00301 ^J	3.519
$^{236}\text{U(F)}$	.0232	2.3825	$^{244}\text{Cm(S)}$	.0044492 ^P	2.69 ^P
$^{236}\text{U(H)}$	.0155	4.151	$^{244}\text{Cm(F)}$	.00435 ^J	3.552
$^{237}\text{U(F)}$	0.03495967	2.502	$^{245}\text{Cm(T)}$	.0059	3.6059
$^{238}\text{U(S)}$	0.0469491 ^P	2.01 ^P	$^{246}\text{Cm(S)}$	.0071116 ^P	3.18 ^P
$^{238}\text{U(F)}$	0.0444	2.5277	$^{246}\text{Cm(F)}$	.00916 ^J	3.578
$^{238}\text{U(H)}$	.026	4.1852	$^{248}\text{Cm(S)}$	.0152465 ^P	3.11 ^P
$^{237}\text{Np(T)}$	0.01081	2.6358	$^{248}\text{Cm(F)}$	.0196 ^J	3.594
$^{237}\text{Np(F)}$	0.01081	2.7107	$^{249}\text{Cf(T)}$	.0027	3.8869
$^{237}\text{Np(H)}$	0.006486	4.7368	$^{250}\text{Cf(S)}$	.0044107 ^P	3.53 ^P
$^{238}\text{Np(F)}$	0.02156	2.864	$^{251}\text{Cf(T)}$	.007530626	4.14
$^{238}\text{Pu(F)}$	0.00418	2.969	$^{252}\text{Cf(S)}$	.0073021 ^P	3.765 ^P
$^{239}\text{Pu(T)}$	0.00645	2.8789	$^{253}\text{Es(S)}$	.0033956 ^P	3.93 ^P
$^{239}\text{Pu(F)}$	0.00645	2.947557	$^{254}\text{Es(T)}$	.005999 ^J	4.0832 ^J
$^{239}\text{Pu(H)}$	.0043	4.943987	$^{254}\text{Fm(S)}$	.0014463 ^P	3.96 ^P
$^{240}\text{Pu(T)}$	.0090	2.803	$^{255}\text{Fm(T)}$	.0063568 ^P	4.00 ^E
$^{240}\text{Pu(F)}$	.0090	2.879	$^{256}\text{Fm(S)}$	.0036334 ^P	4.01 ^P

a Reference values are from ENDF/B-VI except, where noted, from (J) JENDL3.2, (P) Perry & Wilson, '81, (E) an estimate, or (p) present work

EXPONENTIAL SERIES FITS TO PRELIMINARY RESULTS

The STEPIT code (Chandler, 1973) — modified and used locally for more than 25 years for simple representations of fission-product delayed neutrons, decay power, and multigroup decay spectra — was used to fit a sum of n_g exponential terms to the normalized CINDER'90 pulse results. The data to which a fit was made — the calculated delayed neutron production rates divided by the product of the number of fissions and $\bar{\nu}_d$ — describe the normalized temporal distribution of delayed-neutron emission following a single fission pulse. This function, $R_k(t)$, giving the probability of delayed-neutron emission at time t following fission of nuclide k , is of the form

$$R_k(t) = \sum_{i=1}^{n_g} a_{k,i} \lambda_{k,i} e^{-\lambda_{k,i} t}, \quad (1)$$

where $a_{k,i}$ is the fractional abundance of the symbolic temporal group i precursor and $\lambda_{k,i}$ is the radioactive decay constant of that group.

In application, $R_k(t)$ can be integrated with any fission history $F_k(\tau)$ of length T to obtain the delayed-neutron production rate $N_k(T,t)$ given by

$$N_k(T,t) = \bar{\nu}_d \int_0^T F_k(\tau) R_k(T - \tau + t) d\tau, \quad (2)$$

where τ is time from the beginning of the fission history and t is now the decay time from the end of the fission history. For a mixture of K fissioning nuclides, the total delayed-neutron production rate $N(T,t)$ is summed from all contributions:

$$N(T,t) = \sum_{k=1}^K N_k(T,t). \quad (3)$$

For a constant fission history, $F_k(\tau) = F_k$ and Equation (2) becomes

$$N_k(T,t) = \bar{\nu}_d F_k \int_0^T R_k(T - \tau + t) d\tau, \text{ or} \quad (4)$$

$$N_k(T,t) = \bar{\nu}_d F_k R_k(T,t), \quad (5)$$

where $R_k(T,t)$ is the delayed-neutron temporal distribution at time t following a constant unit-fission-rate history of length T .

$$R_k(T,t) = \int_0^T R_k(T - \tau + t) d\tau = \sum_{i=1}^{n_g} a_{k,i} \lambda_{k,i} e^{-\lambda_{k,i} T} e^{-\lambda_{k,i} t} \int_0^T e^{\lambda_{k,i} \tau} d\tau = \sum_{i=1}^6 a_{k,i} e^{-\lambda_{k,i} t} (1 - e^{-\lambda_{k,i} T}). \quad (6)$$

For equilibrium conditions, T is effectively ∞ and

$$R_k(\infty, t) = \sum_{i=1}^{n_g} a_{k,i} e^{-\lambda_{k,i} t}. \quad (7)$$

The delayed-neutron production rates following a unit fission pulse were normalized to a single delayed neutron by dividing by the resolved $\bar{\nu}_d$. These data were input to the code, along with a starting solution for the desired parameters, of which any can be held constant. Those parameters allowed to vary are assigned maximum and minimum values — typically a factor of 20 to 50 above and below the starting value. The code cycles through the parameters, searching for values giving a minimum chi-squared value defined here as the average of the sum of the squares of the *fractional* deviations of the function from CINDER'90 value. This *fractional* deviation is used because of the decrease in $R(t)$ by many orders of magnitude over the 500-s decay time. Also, the square root of this chi-squared value is the RMS deviation of the function from the CINDER'90 values. In practice, each set of parameters thus obtained were then used as starting values in a subsequent STEPIT calculation to insure that no parameters had reached limiting values.

A file of CINDER'90 delayed-neutron production rates following pulse and equilibrium fission were used to produce a file of normalized data to be fit with STEPIT. In each case, the delayed neutron rate following the pulse of 1×10^{10} fissions

was divided by the product of this number of fissions and the calculated \bar{v}_d obtained from the equilibrium calculation. These data were used to obtain four separate fits in which free parameters were systematically varied in a search for a minimum mean squared relative deviation of fitted function and data:

- a 6-group fit in which all group abundances and decay constants were free to vary;
- a 6-group fit in which all group abundances and decay constants were free to vary except that the longest-lived group-1 decay constant was fixed at the value associated with ^{87}Br , with the ENDF/B-VI half-life of 55.67 s used in the calculations;
- an 8-group fit in which all group abundances and decay constants were free to vary; and,
- an 8-group fit in which all group abundances were free to vary but all group decay constants were fixed at the values of major precursors suggested by V. M. Piksaikin as cited and used by Spriggs, Campbell and Piksaikin.(Spriggs, 1999)

The parameters of these four fits are shown in Table 6 for ^{235}U thermal fission, as an example.

Table 6. Parameters of 6- and 8-Group Fits to the Preliminary CINDER'90 $^{235}\text{U}(\text{T})$ Fission Pulse Delayed Neutron Production Rate

Quantity	6 Groups All λ s Free	6 Groups λ_1 Fixed	8 Groups All λ s Free	8 Groups All λ s Fixed
Max Dev, %	0.959	1.151	0.166	1.315
RMS Dev, %	0.368	0.487	0.059	0.367
a_1	0.034984760	0.032941610	0.032460671	0.032837588
λ_1	0.012622130	0.012446530	0.012431940	0.012466680
a_2	0.191290200	0.185823396	0.135909200	0.131976902
λ_2	0.031157210	0.030340631	0.028257420	0.028291721
a_3	0.157941207	0.142114997	0.080130734	0.080719844
λ_3	0.113032803	0.100744799	0.043999441	0.042524371
a_4	0.403800488	0.414896905	0.192177907	0.154661402
λ_4	0.313814491	0.297894210	0.143991500	0.133041695
a_5	0.151554406	0.158214197	0.355838299	0.324151009
λ_5	1.188312054	1.100805998	0.343347698	0.292467207
a_6	0.060428891	0.066008873	0.107858203	0.140478507
λ_6	3.884308100	3.742413044	1.073796988	0.666487694
a_7			0.073309049	0.070790842
λ_7			2.385577917	1.634781003
a_8			0.022315949	0.064383999
λ_8			5.385955811	3.554600954

The typical observations concerning the fits thus produced are as follows:

- conventional 6-group fits with free parameters consistently represented the 54 calculated values with a maximum deviation less than 1% and a significantly smaller RMS deviation;
- 8-group fits with free parameters consistently represented the data with deviations smaller than obtained with 6 groups;
- 8-group fits with fixed decay constants were about as representative of the data as the conventional free-parameter 6-group fits;
- 6-group fits with the decay constant of the long-lived group fixed at the value of ^{87}Br was consistently characterized by larger deviations;
- fits with constrained parameters, in all cases, resulted in larger deviations than fits with the same number of groups without constraints; and,
- there appears to be no value in parameter constraint in obtaining the best representation of these data sets.

Following the completion of this preliminary study, fits were made with STEPIT to the equilibrium delayed neutron production rate defined by Equation (7) above. Reasonable RMS deviations were obtained using pulse-fission derived

parameters in describing the equilibrium-fission results or using equilibrium-fission derived parameters in describing the pulse-fission results. However, large deviations were observed at large decay times when using the pulse-fission derived parameters in describing the equilibrium-fission results; similarly, large deviations were observed at small decay times when using equilibrium-fission derived parameters in describing the pulse-fission results. These observations are illustrated in Table 7 for delayed-neutron production following thermal fission of ^{235}U , where these maximum deviations are in the 2-5% range.

Table 7. Comparison of Preliminary $^{235}\text{U}(\text{T})$ CINDER'90 Pulse and Equilibrium Results with Pulse Functions using Parameters a_i and λ_i from fits to both

Decay Time t, s	Pulse Fission History						Equilibrium Fission History					
	Pulse DN Rate n/s per $\bar{\nu}_{df}$	a_i, λ_i from fit to Pulse		a_i, λ_i from fit to Equilibrium		Equilibrium DN Rate n/s per $\bar{\nu}_{df/s}$	a_i, λ_i from fit to Pulse		a_i, λ_i from fit to Equilibrium		Equilibrium DN Rate n/s per $\bar{\nu}_{df/s}$	a_i, λ_i from fit to Pulse
		n/s per $\bar{\nu}_{df}$	%diff	n/s per $\bar{\nu}_{df}$	%diff		n/s per $\bar{\nu}_{df/s}$	%diff	n/s per $\bar{\nu}_{df/s}$	%diff		n/s per $\bar{\nu}_{df/s}$
0.00	5.68647E-01	5.65791E-01	-0.50	5.42328E-01	-4.63	1.00000E+00	1.00000E+00	0.00	1.00000E+00	0.00	1.00000E+00	0.00
0.01	5.56480E-01	5.54302E-01	-0.39	5.33054E-01	-4.21	9.94373E-01	9.94400E-01	0.00	9.94623E-01	0.03		
0.03	5.33478E-01	5.32411E-01	-0.20	5.15174E-01	-3.43	9.83474E-01	9.83535E-01	0.01	9.84142E-01	0.07		
0.05	5.12114E-01	5.11886E-01	-0.04	4.98148E-01	-2.73	9.73018E-01	9.73094E-01	0.01	9.74011E-01	0.10		
0.07	4.92243E-01	4.92628E-01	0.08	4.81931E-01	-2.09	9.62975E-01	9.63051E-01	0.01	9.64211E-01	0.13		
0.10	4.64954E-01	4.65925E-01	0.21	4.59033E-01	-1.27	9.48620E-01	9.48679E-01	0.01	9.50101E-01	0.16		
0.15	4.25257E-01	4.26583E-01	0.31	4.24358E-01	-0.21	9.26388E-01	9.26392E-01	0.00	9.28033E-01	0.18		
0.20	3.91545E-01	3.92762E-01	0.31	3.93574E-01	0.52	9.05987E-01	9.05929E-01	-0.01	9.07600E-01	0.18		
0.30	3.37730E-01	3.38218E-01	0.14	3.41823E-01	1.21	8.69648E-01	8.69509E-01	-0.02	8.70930E-01	0.15		
0.40	2.96980E-01	2.96755E-01	-0.08	3.00624E-01	1.23	8.37997E-01	8.37851E-01	-0.02	8.38885E-01	0.11		
0.50	2.65208E-01	2.64570E-01	-0.24	2.67565E-01	0.89	8.09946E-01	8.09850E-01	-0.01	8.10535E-01	0.07		
0.60	2.39790E-01	2.39043E-01	-0.31	2.40801E-01	0.42	7.84737E-01	7.84716E-01	0.00	7.85162E-01	0.05		
0.70	2.18999E-01	2.18356E-01	-0.29	2.18919E-01	-0.04	7.61827E-01	7.61881E-01	0.01	7.62212E-01	0.05		
0.80	2.01665E-01	2.01244E-01	-0.21	2.00835E-01	-0.41	7.40817E-01	7.40926E-01	0.01	7.41252E-01	0.06		
0.90	1.86977E-01	1.86820E-01	-0.08	1.85720E-01	-0.67	7.21402E-01	7.21542E-01	0.02	7.21946E-01	0.08		
1.00	1.74357E-01	1.74453E-01	0.05	1.72936E-01	-0.82	7.03348E-01	7.03494E-01	0.02	7.04031E-01	0.10		
1.20	1.53748E-01	1.54211E-01	0.30	1.52514E-01	-0.80	6.70624E-01	6.70713E-01	0.01	6.71583E-01	0.14		
1.50	1.30704E-01	1.31320E-01	0.47	1.30260E-01	-0.34	6.28142E-01	6.28061E-01	-0.01	6.29361E-01	0.19		
2.00	1.04463E-01	1.04744E-01	0.27	1.05047E-01	0.56	5.69819E-01	5.69502E-01	-0.06	5.70971E-01	0.20		
2.50	8.65719E-02	8.64712E-02	-0.12	8.73820E-02	0.94	5.22309E-01	5.21955E-01	-0.07	5.23086E-01	0.15		
3.00	7.33671E-02	7.30986E-02	-0.37	7.39636E-02	0.81	4.82474E-01	4.82222E-01	-0.05	4.82890E-01	0.09		
3.50	6.31117E-02	6.28505E-02	-0.41	6.33918E-02	0.44	4.48453E-01	4.48339E-01	-0.03	4.48651E-01	0.04		
4.00	5.48789E-02	5.47087E-02	-0.31	5.48978E-02	0.03	4.19026E-01	4.19022E-01	0.00	4.19153E-01	0.03		
4.50	4.81224E-02	4.80603E-02	-0.13	4.79789E-02	-0.30	3.93329E-01	3.93383E-01	0.01	3.93491E-01	0.04		
5.00	4.24923E-02	4.25208E-02	0.07	4.22774E-02	-0.51	3.70717E-01	3.70778E-01	0.02	3.70972E-01	0.07		
6.00	3.37172E-02	3.38384E-02	0.36	3.35347E-02	-0.54	3.32850E-01	3.32826E-01	-0.01	3.33317E-01	0.14		
7.00	2.73002E-02	2.74199E-02	0.44	2.72403E-02	-0.22	3.02502E-01	3.02352E-01	-0.05	3.03093E-01	0.20		
8.00	2.25037E-02	2.25780E-02	0.33	2.25582E-02	0.24	2.77713E-01	2.77464E-01	-0.09	2.78303E-01	0.21		
9.00	1.88552E-02	1.88764E-02	0.11	1.89817E-02	0.67	2.57115E-01	2.56817E-01	-0.12	2.57610E-01	0.19		
10.00	1.60371E-02	1.60150E-02	-0.14	1.61915E-02	0.96	2.39728E-01	2.39432E-01	-0.12	2.40079E-01	0.15		
12.00	1.20762E-02	1.20126E-02	-0.53	1.22003E-02	1.03	2.11919E-01	2.11717E-01	-0.10	2.11977E-01	0.03		
15.00	8.56963E-03	8.52068E-03	-0.57	8.59078E-03	0.25	1.81473E-01	1.81453E-01	-0.01	1.81314E-01	-0.09		
20.00	5.63108E-03	5.63916E-03	0.14	5.57954E-03	-0.92	1.46920E-01	1.46990E-01	0.05	1.46897E-01	-0.02		
25.00	4.14086E-03	4.16470E-03	0.58	4.11063E-03	-0.73	1.22845E-01	1.22818E-01	-0.02	1.23042E-01	0.16		
30.00	3.24008E-03	3.25441E-03	0.44	3.24032E-03	0.01	1.04556E-01	1.04428E-01	-0.12	1.04822E-01	0.25		
35.00	2.62907E-03	2.63055E-03	0.06	2.64406E-03	0.57	8.99708E-02	8.98035E-02	-0.19	9.01916E-02	0.25		
40.00	2.18175E-03	2.17506E-03	-0.31	2.19856E-03	0.77	7.79967E-02	7.78443E-02	-0.20	7.81337E-02	0.18		
45.00	1.83703E-03	1.82733E-03	-0.53	1.84971E-03	0.69	6.79846E-02	6.78746E-02	-0.16	6.80462E-02	0.09		
50.00	1.56202E-03	1.55274E-03	-0.59	1.56930E-03	0.47	5.95115E-02	5.94498E-02	-0.10	5.95231E-02	0.02		
60.00	1.15106E-03	1.14642E-03	-0.40	1.15082E-03	-0.02	4.60742E-02	4.60832E-02	0.02	4.60551E-02	-0.04		
70.00	8.62515E-04	8.62108E-04	-0.05	8.60034E-04	-0.29	3.60873E-02	3.61195E-02	0.09	3.60849E-02	-0.01		
80.00	6.54111E-04	6.55858E-04	0.27	6.52111E-04	-0.31	2.85592E-02	2.85828E-02	0.08	2.85802E-02	0.07		
90.00	5.01138E-04	5.03407E-04	0.45	5.00299E-04	-0.17	2.28217E-02	2.28240E-02	0.01	2.28567E-02	0.15		
100.00	3.87591E-04	3.89508E-04	0.50	3.87708E-04	0.03	1.84059E-02	1.83866E-02	-0.10	1.84440E-02	0.21		
110.00	3.02534E-04	3.03782E-04	0.41	3.03192E-04	0.22	1.49755E-02	1.49402E-02	-0.24	1.50093E-02	0.23		
120.00	2.38284E-04	2.38857E-04	0.24	2.39130E-04	0.35	1.22863E-02	1.22419E-02	-0.36	1.23123E-02	0.21		
150.00	1.22720E-04	1.22150E-04	-0.47	1.23200E-04	0.39	7.09508E-03	7.05412E-03	-0.58	7.09940E-03	0.06		
200.00	4.75498E-05	4.70938E-05	-0.96	4.75024E-05	-0.10	3.18910E-03	3.17862E-03	-0.33	3.18594E-03	-0.10		
250.00	2.13667E-05	2.12866E-05	-0.38	2.13145E-05	-0.24	1.56833E-03	1.57012E-03	0.11	1.56847E-03	0.01		
300.00	1.04950E-05	1.05312E-05	0.34	1.04919E-05	-0.03	8.07784E-04	8.09846E-04	0.26	8.09171E-04	0.17		
350.00	5.40091E-06	5.43555E-06	0.64	5.41240E-06	0.21	4.25398E-04	4.25478E-04	0.02	4.26459E-04	0.25		
400.00	2.84290E-06	2.85655E-06	0.48	2.85242E-06	0.34	2.26346E-04	2.25226E-04	-0.49	2.26851E-04	0.22		
450.00	1.51229E-06	1.51228E-06	0.00	1.51730E-06	0.33	1.21003E-04	1.19583E-04	-1.17	1.21148E-04	0.12		
500.00	8.08374E-07	8.02978E-07	-0.67	8.10296E-07	0.24	6.48267E-05	6.35686E-05	-1.94	6.48052E-05	-0.03		

COMPREHENSIVE CALCULATIONS OF AGGREGATE DELAYED-NEUTRON PRODUCTION RATES

In order to produce pulse functions for each system that are applicable to a wide range of applications, a new series of CINDER'90 calculations were undertaken to describe delayed-neutron production following a wide range of fission histories. Fission histories of 0.1 ms (pulse), 1 s, 10 s, 100 s, 1000 s, and 4 hours were selected. Sixty decay times were included, extending now to 800 s. For each system, the delayed-neutron production rate at each of the fission time – decay time combinations was now included in a single fit for $F(T,t)$ given by Equation (6). Fits were made for 6 exponential terms, allowing all a_i and λ_i to vary.

The group abundances a_i and decay constants λ_i of each of the conventional six-group functions, as well as the maximum and RMS deviations of the functions from the data, are given in Table 9.

Additional fits were made for 8 exponential terms with the λ_i fixed at the values selected by Piksaikin. The parameters of these fits are given in Table 10.

VALIDATION OF FUNCTIONS

The efficacy of the six-group functions in the representation of aggregate delayed-neutron production from detailed summation calculations provides little assurance in the accuracy of the functions in representing the physical systems. Spriggs and Campbell have significantly reduced the toil in the production of meaningful comparisons with measured observables with their accumulation of all measured few-group functions in a single document (Spriggs and Campbell, 1999) and in sharing the accumulated data by placing it on the web.

We have compared the 6-group and 8-group fits produced in this work with functions resolved from the measurements included in the Spriggs-Campbell survey. Each function $R(t)$ is characterized by listing its value at several times following fission. Also, point-reactor kinetics calculations were made with each function using the AIREK-10 code (Perry et al. 1986) — a local improvement on the AIREK-3 code. (Blue and Hoffman, 1963) The asymptotic periods, evaluated at 200 seconds after positive step reactivity insertions of 10ϕ , 25ϕ , 40ϕ and 50ϕ , were obtained with each function using the reference \bar{v}_t , \bar{v}_d and β values given in or deduced from Table 5; companion kinetics calculations were also made for each measurement-based function using the \bar{v}_t and \bar{v}_d values given for each by Spriggs and Campbell. No attempt was made to evaluate the more applicable β_{eff} value for any of the kinetics calculations. The results of these survey calculations are given in Table 11. References for tabulated data may be found in the summary of group parameters by Spriggs and Campbell.

CONCLUSIONS

We have provided updated calculations of \bar{v}_d and temporal delayed-neutron production for 36 nuclides at one or more fission neutron energies and/or spontaneous fission (sixty fission systems). All calculations are based on ENDF/B-VI decay and yield data and a reference set of Pn data. The major change from previous work has been the inclusion of results from a range of fission histories, use of ENDF/B-VI fission-product yield and decay data, and the use of CINDER'90 — which incorporates all decay types in coupled nuclides, including isomeric transition, beta and gamma decay and delayed neutron couplings. The yields also incorporate these coupling parameters in the evaluation.

Calculations are very detailed and not approximated. That is, each product includes contributions from all contributors as a function of time. Delayed neutrons vs decay time are as precise as are the yield, Pn, half-life, and other coupling parameters. The conclusions here are based on this data base and CINDER'90 code calculations and would not likely change significantly with another data base as regards the ability to approximate the detailed calculations.

Approximations use few time groups as singly produced fictitious nuclides. Such approximations can be very good, but the user should keep in mind that such approximations are an attempt to reproduce a very complicated behavior of approximately 386 fission-product nuclides — including 115 β^- precursors and the 271 (β^-, n) delayed neutron emitters — with six or eight, or so, uncoupled precursors.

Traditionally six time groups have been used to approximate the more exact time behavior, and we see no compelling reason to depart from this. However, because of interest in the use of eight groups with a fixed set of lambdas, we have produced and include such eight-group parameters for all 60 cases.

Examining the comprehensive fits for six groups with variable abundances and lambdas — the traditional representation — we see generally that the six groups provided a slightly better fit to the calculated time-behavior than did the use of a fixed set of lambdas in eight groups. The six-group fits have the smallest RMS deviation for 29 systems and the smallest maximum deviation for 39 systems, with the maximum exceeding 1% for two systems (1.02% and 1.291% for seven systems (1.04% – 1.69%). RMS deviations for all fits are likely smaller than the estimated uncertainty in \bar{v}_d .

It is no surprise that the use of 8 groups with variable lambdas is better in all 60 cases than six groups, but the difference is not significant in terms of the uncertainty in $\bar{\nu}_d$. If users desire 8 groups, we recommend they permit variable lambdas. We note that the use of 8 groups with fixed lambdas does provide slightly better fits than we expected. It appears, however, that even greater accuracy is available by removing constraints of the decay constants.

Our basic conclusion, based on the ability to fit the $\bar{\nu}_d$ calculations with few time groups is that we see no need for reactor design codes to depart from the use of six decay groups with variable lambdas, although the penalty for using 8-groups with fixed lambdas is not large. This comment is independent of the best value to use for $\bar{\nu}_d$. The failure of fits to results following pulse fission in the representation of equilibrium delayed-neutron production at large decay times in the preliminary study emphasizes the need for the inclusion of results following extensive fission histories in calculations and measurements, as suggested by Keepin et al.(Keepin et al. 1958).

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Table 8. Comprehensive ^{235}U (T) CINDER'90 Results (n/s per $\bar{\nu}_d$ f/s)
and Deviations of the Comprehensive Fits From Them

Decay Time t, s	0.1-millisecond Fission History		1-second Fission History		10-second Fission History	
	DN Rate	%diff	DN Rate	%diff	DN Rate	%diff
0.00	5.68647E-05	-0.77	2.96625E-01	-0.01	7.60255E-01	0.04
0.01	5.56480E-05	-0.60	2.92736E-01	0.00	7.54788E-01	0.05
0.03	5.33478E-05	-0.29	2.85279E-01	0.01	7.44209E-01	0.06
0.05	5.12114E-05	-0.04	2.78220E-01	0.02	7.34072E-01	0.06
0.07	4.92243E-05	0.17	2.71529E-01	0.01	7.24347E-01	0.06
0.10	4.64954E-05	0.41	2.62125E-01	-0.01	7.10467E-01	0.06
0.15	4.25257E-05	0.63	2.47940E-01	-0.06	6.89022E-01	0.04
0.20	3.91545E-05	0.69	2.35343E-01	-0.12	6.69401E-01	0.02
0.30	3.37730E-05	0.49	2.13948E-01	-0.24	6.34608E-01	-0.01
0.40	2.96980E-05	0.12	1.96432E-01	-0.29	6.04478E-01	-0.03
0.50	2.65208E-05	-0.23	1.81791E-01	-0.27	5.77926E-01	-0.02
0.60	2.39790E-05	-0.48	1.69339E-01	-0.20	5.54193E-01	-0.01
0.70	2.18999E-05	-0.61	1.58593E-01	-0.09	5.32739E-01	0.02
0.80	2.01665E-05	-0.61	1.49203E-01	0.04	5.13162E-01	0.04
0.90	1.86977E-05	-0.52	1.40912E-01	0.18	4.95160E-01	0.07
1.00	1.74357E-05	-0.37	1.33523E-01	0.30	4.78500E-01	0.09
1.20	1.53748E-05	0.01	1.20886E-01	0.47	4.48503E-01	0.11
1.50	1.30704E-05	0.47	1.05831E-01	0.54	4.09974E-01	0.09
2.00	1.04463E-05	0.61	8.73438E-02	0.25	3.57894E-01	0.00
2.50	8.65719E-06	0.24	7.38547E-02	-0.17	3.16234E-01	-0.07
3.00	7.33671E-06	-0.22	6.34469E-02	-0.49	2.81896E-01	-0.09
3.50	6.31117E-06	-0.53	5.51239E-02	-0.61	2.53056E-01	-0.06
4.00	5.48789E-06	-0.64	4.83096E-02	-0.56	2.28522E-01	0.00
4.50	4.81224E-06	-0.57	4.26396E-02	-0.40	2.07458E-01	0.06
5.00	4.24923E-06	-0.40	3.78669E-02	-0.18	1.89242E-01	0.11
6.00	3.37172E-06	0.06	3.03482E-02	0.25	1.59539E-01	0.13
7.00	2.73002E-06	0.43	2.47895E-02	0.52	1.36628E-01	0.05
8.00	2.25037E-06	0.59	2.05988E-02	0.59	1.18660E-01	-0.10
9.00	1.88552E-06	0.55	1.73873E-02	0.46	1.04356E-01	-0.27
10.00	1.60371E-06	0.35	1.48897E-02	0.22	9.28078E-02	-0.43
12.00	1.20762E-06	-0.22	1.13463E-02	-0.35	7.55312E-02	-0.59
15.00	8.56963E-07	-0.81	8.16297E-03	-0.83	5.86280E-02	-0.44
20.00	5.63108E-07	-0.43	5.44110E-03	-0.34	4.23641E-02	0.28
25.00	4.14086E-07	0.42	4.03238E-03	0.48	3.28743E-02	0.68
30.00	3.24008E-07	0.78	3.16928E-03	0.78	2.65594E-02	0.59
35.00	2.62907E-07	0.61	2.57858E-03	0.57	2.19864E-02	0.22
40.00	2.18175E-07	0.19	2.14354E-03	0.14	1.84852E-02	-0.20
45.00	1.83703E-07	-0.24	1.80692E-03	-0.28	1.57034E-02	-0.53
50.00	1.56202E-07	-0.57	1.53763E-03	-0.59	1.34374E-02	-0.72
60.00	1.15106E-07	-0.80	1.13425E-03	-0.79	9.98701E-03	-0.72
70.00	8.62515E-08	-0.60	8.50488E-04	-0.58	7.52820E-03	-0.42
80.00	6.54111E-08	-0.22	6.45336E-04	-0.20	5.73755E-03	-0.03
90.00	5.01138E-08	0.16	4.94654E-04	0.18	4.41585E-03	0.31
100.00	3.87591E-08	0.45	3.82752E-04	0.46	3.43041E-03	0.55
110.00	3.02534E-08	0.62	2.98893E-04	0.62	2.68926E-03	0.65
120.00	2.38284E-08	0.66	2.35522E-04	0.65	2.12724E-03	0.63
150.00	1.22721E-08	0.23	1.21454E-04	0.22	1.10915E-03	0.13
200.00	4.75498E-09	-0.74	4.71429E-05	-0.75	4.37107E-04	-0.80
250.00	2.13667E-09	-0.88	2.12085E-05	-0.88	1.98587E-04	-0.85
300.00	1.04950E-09	-0.47	1.04240E-05	-0.47	9.81326E-05	-0.42
350.00	5.40091E-10	-0.02	5.36608E-06	-0.02	5.06516E-05	0.01
400.00	2.84290E-10	0.26	2.82498E-06	0.26	2.66993E-05	0.28
450.00	1.51229E-10	0.38	1.50287E-06	0.38	1.42120E-05	0.38
500.00	8.08374E-11	0.38	8.03363E-07	0.38	7.59908E-06	0.38
550.00	4.33058E-11	0.32	4.30380E-07	0.32	4.07149E-06	0.31
600.00	2.32228E-11	0.22	2.30793E-07	0.22	2.18348E-06	0.21
650.00	1.24589E-11	0.10	1.23820E-07	0.10	1.17146E-06	0.09
700.00	6.68553E-12	-0.02	6.64425E-08	-0.03	6.28619E-07	-0.04
750.00	3.58783E-12	-0.16	3.56568E-08	-0.16	3.37354E-07	-0.17
800.00	1.92551E-12	-0.29	1.91362E-08	-0.30	1.81051E-07	-0.31

Table 8. Comprehensive ^{235}U (T) CINDER'90 Results (n/s per $\bar{\nu}_d$ f/s)
and Deviations of the Comprehensive Fits From Them (Continued)

Decay Time t, s	100-second Fission History		1000-second Fission History		4-hour Fission History	
	DN Rate	%diff	DN Rate	%diff	DN Rate	%diff
0.00	9.81591E-01	0.00	9.99999E-01	0.00	1.00000E+00	0.00
0.01	9.75969E-01	0.00	9.94373E-01	0.00	9.94373E-01	0.00
0.03	9.65077E-01	0.01	9.83474E-01	0.01	9.83474E-01	0.01
0.05	9.54629E-01	0.01	9.73018E-01	0.01	9.73018E-01	0.01
0.07	9.44594E-01	0.01	9.62974E-01	0.01	9.62975E-01	0.01
0.10	9.30252E-01	0.00	9.48620E-01	0.01	9.48620E-01	0.01
0.15	9.08038E-01	-0.01	9.26388E-01	-0.01	9.26388E-01	-0.01
0.20	8.87656E-01	-0.03	9.05986E-01	-0.02	9.05987E-01	-0.02
0.30	8.51357E-01	-0.05	8.69648E-01	-0.05	8.69648E-01	-0.05
0.40	8.19744E-01	-0.07	8.37997E-01	-0.06	8.37997E-01	-0.06
0.50	7.91730E-01	-0.07	8.09945E-01	-0.06	8.09946E-01	-0.06
0.60	7.66560E-01	-0.06	7.84737E-01	-0.05	7.84737E-01	-0.05
0.70	7.43688E-01	-0.04	7.61827E-01	-0.03	7.61827E-01	-0.03
0.80	7.22716E-01	-0.02	7.40817E-01	-0.02	7.40817E-01	-0.02
0.90	7.03339E-01	-0.01	7.21401E-01	0.00	7.21402E-01	0.00
1.00	6.85323E-01	0.00	7.03348E-01	0.01	7.03348E-01	0.01
1.20	6.52674E-01	0.01	6.70623E-01	0.02	6.70624E-01	0.02
1.50	6.10305E-01	0.00	6.28142E-01	0.00	6.28142E-01	0.00
2.00	5.52168E-01	-0.07	5.69819E-01	-0.06	5.69819E-01	-0.06
2.50	5.04840E-01	-0.11	5.22309E-01	-0.10	5.22309E-01	-0.10
3.00	4.65186E-01	-0.12	4.82473E-01	-0.11	4.82474E-01	-0.11
3.50	4.31344E-01	-0.10	4.48453E-01	-0.09	4.48453E-01	-0.09
4.00	4.02093E-01	-0.07	4.19026E-01	-0.06	4.19026E-01	-0.06
4.50	3.76570E-01	-0.03	3.93329E-01	-0.02	3.93329E-01	-0.02
5.00	3.54130E-01	0.00	3.70717E-01	0.01	3.70717E-01	0.01
6.00	3.16602E-01	0.02	3.32850E-01	0.03	3.32850E-01	0.03
7.00	2.86583E-01	0.00	3.02502E-01	0.01	3.02502E-01	0.01
8.00	2.62116E-01	-0.05	2.77713E-01	-0.04	2.77713E-01	-0.04
9.00	2.41832E-01	-0.10	2.57115E-01	-0.09	2.57115E-01	-0.09
10.00	2.24751E-01	-0.15	2.39728E-01	-0.13	2.39728E-01	-0.13
12.00	1.97533E-01	-0.18	2.11919E-01	-0.16	2.11919E-01	-0.16
15.00	1.67921E-01	-0.11	1.81473E-01	-0.09	1.81473E-01	-0.09
20.00	1.34633E-01	0.06	1.46920E-01	0.06	1.46920E-01	0.06
25.00	1.11682E-01	0.08	1.22845E-01	0.07	1.22845E-01	0.07
30.00	9.43959E-02	-0.02	1.04556E-01	-0.03	1.04556E-01	-0.03
35.00	8.07065E-02	-0.15	8.99707E-02	-0.16	8.99708E-02	-0.16
40.00	6.95344E-02	-0.24	7.79965E-02	-0.24	7.79967E-02	-0.24
45.00	6.02419E-02	-0.27	6.79845E-02	-0.28	6.79846E-02	-0.28
50.00	5.24159E-02	-0.24	5.95114E-02	-0.26	5.95115E-02	-0.26
60.00	4.00878E-02	-0.07	4.60742E-02	-0.12	4.60742E-02	-0.12
70.00	3.10085E-02	0.14	3.60873E-02	0.04	3.60873E-02	0.04
80.00	2.42288E-02	0.31	2.85591E-02	0.17	2.85592E-02	0.17
90.00	1.91128E-02	0.38	2.28217E-02	0.21	2.28217E-02	0.21
100.00	1.52166E-02	0.36	1.84059E-02	0.19	1.84059E-02	0.19
110.00	1.22233E-02	0.27	1.49755E-02	0.11	1.49755E-02	0.11
120.00	9.90397E-03	0.12	1.22863E-02	-0.01	1.22863E-02	-0.01
150.00	5.52665E-03	-0.41	7.09506E-03	-0.40	7.09508E-03	-0.40
200.00	2.38127E-03	-0.82	3.18909E-03	-0.62	3.18910E-03	-0.62
250.00	1.14290E-03	-0.56	1.56832E-03	-0.35	1.56833E-03	-0.35
300.00	5.81425E-04	-0.13	8.07781E-04	-0.01	8.07784E-04	-0.01
350.00	3.04388E-04	0.19	4.25396E-04	0.22	4.25398E-04	0.22
400.00	1.61515E-04	0.35	2.26345E-04	0.32	2.26346E-04	0.32
450.00	8.62372E-05	0.38	1.21003E-04	0.31	1.21003E-04	0.31
500.00	4.61746E-05	0.33	6.48264E-05	0.24	6.48267E-05	0.24
550.00	2.47554E-05	0.24	3.47641E-05	0.14	3.47642E-05	0.14
600.00	1.32797E-05	0.13	1.86510E-05	0.02	1.86511E-05	0.02
650.00	7.12562E-06	0.00	1.00083E-05	-0.11	1.00083E-05	-0.11
700.00	3.82392E-06	-0.13	5.37100E-06	-0.24	5.37103E-06	-0.24
750.00	2.05220E-06	-0.26	2.88250E-06	-0.38	2.88252E-06	-0.38
800.00	1.10138E-06	-0.40	1.54701E-06	-0.51	1.54701E-06	-0.51

Table 9. 6-Group Parameters from Unconstrained STEPIT Fits to CINDER'90 Results for a Range of Fission Histories and Decay Times Extending to 800 s

ID	Deviation, %		Time Group Parameters					
	RMS	Max	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
$^{227}\text{Th}(\text{T})$	0.102	0.336	$a_i:$ 0.1620934 $\lambda_i:$ 0.0124550	0.2621574 0.0305853	0.1077244 0.0724770	0.3006624 0.2134217	0.1482439 0.4706730	0.0191185 2.1611510
$^{229}\text{Th}(\text{T})$	0.124	0.404	$a_i:$ 0.1100013 $\lambda_i:$ 0.0124559	0.2224731 0.0311343	0.1117372 0.0619166	0.3135620 0.2050065	0.2058221 0.4783685	0.0364043 1.9590060
$^{232}\text{Th}(\text{F})$	0.269	0.944	$a_i:$ 0.0292904 $\lambda_i:$ 0.0124708	0.0834987 0.0351770	0.1209884 0.1111550	0.4816023 0.3022868	0.1901650 0.8201746	0.0944552 2.7069430
$^{232}\text{Th}(\text{H})$	0.320	1.023	$a_i:$ 0.0198822 $\lambda_i:$ 0.0124747	0.0706069 0.0319861	0.0833818 0.1044033	0.5302612 0.3069075	0.1764373 0.8604661	0.1194305 3.0843440
$^{231}\text{Pa}(\text{F})$	0.138	0.448	$a_i:$ 0.0770354 $\lambda_i:$ 0.0124570	0.2103882 0.0304075	0.1058916 0.0617661	0.3160344 0.1943767	0.2455945 0.4262802	0.0450559 2.2338350
$^{232}\text{U}(\text{T})$	0.116	0.329	$a_i:$ 0.1053767 $\lambda_i:$ 0.0124548	0.2466141 0.0303027	0.1191537 0.0596483	0.3288551 0.1890047	0.1659109 0.4527756	0.0340895 2.2308830
$^{233}\text{U}(\text{T})$	0.226	0.641	$a_i:$ 0.0713663 $\lambda_i:$ 0.0124645	0.2331653 0.0307039	0.1295138 0.0833799	0.3898789 0.2529981	0.1355374 0.6613854	0.0405383 3.0239220
$^{233}\text{U}(\text{F})$	0.145	0.441	$a_i:$ 0.0845351 $\lambda_i:$ 0.0124577	0.2250679 0.0305592	0.1118724 0.06666204	0.3466863 0.2029487	0.1906806 0.4746651	0.0411578 2.2215690
$^{233}\text{U}(\text{H})$	0.216	0.642	$a_i:$ 0.0609236 $\lambda_i:$ 0.0124631	0.1574096 0.0324381	0.1058600 0.0777293	0.4100480 0.2344183	0.1972015 0.5491273	0.0685573 2.4774330
$^{234}\text{U}(\text{F})$	0.182	0.523	$a_i:$ 0.0547629 $\lambda_i:$ 0.0124598	0.2139315 0.0299534	0.1016215 0.0713636	0.3606888 0.2100830	0.2116634 0.4966194	0.0573318 2.3269000
$^{234}\text{U}(\text{H})$	0.205	0.619	$a_i:$ 0.0669175 $\lambda_i:$ 0.0124628	0.1579062 0.0323008	0.1030433 0.0806738	0.4202968 0.2438469	0.1876413 0.5663644	0.0641950 2.4939850
$^{235}\text{U}(\text{T})$	0.320	0.881	$a_i:$ 0.0332036 $\lambda_i:$ 0.0124740	0.1840844 0.0303001	0.1305579 0.0955406	0.4109865 0.2844131	0.1642760 0.9781931	0.0768915 3.4888240
$^{235}\text{U}(\text{F})$	0.288	0.856	$a_i:$ 0.0315500 $\lambda_i:$ 0.0124693	0.1538402 0.0306173	0.1031064 0.0817368	0.4117655 0.2439838	0.2077502 0.6109766	0.0919878 2.7371780
$^{235}\text{U}(\text{H})$	0.278	0.858	$a_i:$ 0.0322185 $\lambda_i:$ 0.0124665	0.1290051 0.0314075	0.0839339 0.0723182	0.4101084 0.2284487	0.2525017 0.5279488	0.0922324 2.4873810
$^{236}\text{U}(\text{F})$	0.290	0.844	$a_i:$ 0.0248701 $\lambda_i:$ 0.0124710	0.1811877 0.0298007	0.1139590 0.0879243	0.3953723 0.2579327	0.1922654 0.7126081	0.0923454 2.7415020
$^{236}\text{U}(\text{H})$	0.276	0.750	$a_i:$ 0.0336783 $\lambda_i:$ 0.0124694	0.1366023 0.0306795	0.1061835 0.0927793	0.4439848 0.2642471	0.1803464 0.7073055	0.0992047 2.7298650
$^{237}\text{U}(\text{F})$	0.324	0.917	$a_i:$ 0.0148226 $\lambda_i:$ 0.0124743	0.1683826 0.0295227	0.1013667 0.0850993	0.3896304 0.2565651	0.2212212 0.7143527	0.1045764 2.8201980
$^{238}\text{U}(\text{S})$	0.287	0.776	$a_i:$ 0.0088069 $\lambda_i:$ 0.0124718	0.1047874 0.0291488	0.0809709 0.1061400	0.4065178 0.3024594	0.2567816 0.9365440	0.1421353 3.0173730
$^{238}\text{U}(\text{F})$	0.345	0.978	$a_i:$ 0.0101087 $\lambda_i:$ 0.0124770	0.1115611 0.0295054	0.0971151 0.0997278	0.4067582 0.2909577	0.2464966 0.8609275	0.1279603 3.0224630
$^{238}\text{U}(\text{H})$	0.346	0.984	$a_i:$ 0.0147673 $\lambda_i:$ 0.0124766	0.1057459 0.0300099	0.1125037 0.1002534	0.4228695 0.2888079	0.2143608 0.8855543	0.1297528 3.0924840
$^{237}\text{Np}(\text{T})$	0.238	0.696	$a_i:$ 0.0250027 $\lambda_i:$ 0.0124667	0.2087344 0.0293958	0.1070586 0.0830217	0.3834204 0.2426566	0.1954484 0.6074778	0.0803356 2.4733820
$^{237}\text{Np}(\text{F})$	0.241	0.700	$a_i:$ 0.0310521 $\lambda_i:$ 0.0124671	0.1830540 0.0298451	0.1140236 0.0845368	0.4059910 0.2488776	0.1874169 0.6129365	0.0784624 2.5176390
$^{237}\text{Np}(\text{H})$	0.266	0.753	$a_i:$ 0.0238567 $\lambda_i:$ 0.0124688	0.1619962 0.0296917	0.1060142 0.0881503	0.4310482 0.2531130	0.1753144 0.6692973	0.1017704 2.6233480
$^{238}\text{Np}(\text{F})$	0.238	0.645	$a_i:$ 0.0178971 $\lambda_i:$ 0.0124684	0.2204071 0.0291308	0.1169065 0.0876491	0.3888350 0.2564575	0.1807436 0.6761683	0.0752108 2.6576280
$^{238}\text{Pu}(\text{F})$	0.220	0.642	$a_i:$ 0.0343141 $\lambda_i:$ 0.0124648	0.2142067 0.0295803	0.1069120 0.0818543	0.3934650 0.2399618	0.1811554 0.5954853	0.0699468 2.5908910
$^{239}\text{Pu}(\text{T})$	0.185	0.492	$a_i:$ 0.0245962 $\lambda_i:$ 0.0124636	0.2639298 0.0289692	0.1357436 0.0909987	0.3570647 0.2548831	0.1517251 0.6237017	0.0669406 2.3580260
$^{239}\text{Pu}(\text{F})$	0.199	0.548	$a_i:$ 0.0323789 $\lambda_i:$ 0.0124645	0.2565405 0.0292278	0.1376702 0.0890222	0.3607305 0.2521876	0.1531104 0.6414486	0.0595694 2.5766300
$^{239}\text{Pu}(\text{H})$	0.257	0.807	$a_i:$ 0.0411966 $\lambda_i:$ 0.0124655	0.1442955 0.0313179	0.0834876 0.0745888	0.4286666 0.2463018	0.2165997 0.5699594	0.0857540 2.6270540
$^{240}\text{Pu}(\text{T})$	0.224	0.618	$a_i:$ 0.0190110 $\lambda_i:$ 0.0124666	0.2590734 0.0290212	0.1051019 0.0829846	0.3676458 0.2536890	0.1774145 0.6585162	0.0717533 2.5891790
$^{240}\text{Pu}(\text{F})$	0.214	0.555	$a_i:$ 0.0206558 $\lambda_i:$ 0.0124662	0.2455922 0.0290247	0.1158715 0.0904018	0.3825392 0.2622833	0.1657725 0.6942956	0.0695688 2.6464520

Table 9. 6-Group Parameters from Unconstrained STEPIT Fits to CINDER'90 Results for a Range of Fission Histories and Decay Times Extending to 800 s (Continued)

ID	Deviation, %		Time Group Parameters					
	RMS	Max	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
$^{240}\text{Pu(H)}$	0.263	0.766	$a_i:$ 0.0334526 $\lambda_i:$ 0.0124679	0.1587557 0.0302522	0.1004346 0.0855894	0.4325497 0.2602530	0.1849649 0.6706397	0.0898426 2.7011770
$^{241}\text{Pu(T)}$	0.219	0.567	$a_i:$ 0.0124114 $\lambda_i:$ 0.0124683	0.2396255 0.0288547	0.1257641 0.0935951	0.3781457 0.2770383	0.1756789 0.7655351	0.0683744 2.8139380
$^{241}\text{Pu(F)}$	0.241	0.608	$a_i:$ 0.0135531 $\lambda_i:$ 0.0124692	0.2306264 0.0289546	0.1111739 0.0901886	0.3813815 0.2712077	0.1822003 0.7507582	0.0810648 2.8104100
$^{242}\text{Pu(T)}$	0.272	0.742	$a_i:$ 0.0086447 $\lambda_i:$ 0.0124726	0.2048606 0.0288947	0.1046370 0.0918432	0.3787296 0.2854126	0.2098346 0.8241763	0.0932936 2.9998660
$^{242}\text{Pu(F)}$	0.292	0.770	$a_i:$ 0.0089388 $\lambda_i:$ 0.0124741	0.1728885 0.0290292	0.1078482 0.0935969	0.3948980 0.2805638	0.2131797 0.8118087	0.1022469 3.0028200
$^{242}\text{Pu(H)}$	0.298	0.808	$a_i:$ 0.0144174 $\lambda_i:$ 0.0124725	0.1452768 0.0293944	0.0983875 0.0929573	0.4246266 0.2857305	0.2022961 0.8100868	0.1149957 2.9676720
$^{241}\text{Am(T)}$	0.177	0.459	$a_i:$ 0.0235474 $\lambda_i:$ 0.0124633	0.2952067 0.0288858	0.1245672 0.0892334	0.3621915 0.2574087	0.1427824 0.6435218	0.0517049 2.5005870
$^{241}\text{Am(F)}$	0.172	0.519	$a_i:$ 0.0344982 $\lambda_i:$ 0.0124614	0.2949948 0.0291309	0.1052443 0.0734948	0.3420685 0.2277045	0.1795340 0.5304473	0.0436601 2.3822360
$^{241}\text{Am(H)}$	0.224	0.676	$a_i:$ 0.0458802 $\lambda_i:$ 0.0124642	0.1569630 0.0306284	0.1066743 0.0820674	0.3999792 0.2493858	0.2169259 0.5926658	0.0735774 2.4824100
$^{42m}\text{Am(T)}$	0.209	0.535	$a_i:$ 0.0175195 $\lambda_i:$ 0.0124661	0.2726099 0.0288907	0.1182086 0.0886339	0.3712239 0.2608605	0.1581833 0.6835279	0.0622548 2.6957680
$^{243}\text{Am(F)}$	0.217	0.545	$a_i:$ 0.0163108 $\lambda_i:$ 0.0124667	0.2601239 0.0288936	0.1105743 0.0897125	0.3828182 0.2687043	0.1592469 0.7255981	0.0709259 2.7875890
$^{242}\text{Cm(F)}$	0.190	0.693	$a_i:$ 0.0534393 $\lambda_i:$ 0.0124362	0.2145977 0.0274322	0.1316083 0.0392166	0.2412159 0.1610232	0.3082608 0.3952282	0.0508780 2.1065130
$^{243}\text{Cm(T)}$	0.208	0.558	$a_i:$ 0.0280531 $\lambda_i:$ 0.0124647	0.2518904 0.0290767	0.1101012 0.0925308	0.3932693 0.2701668	0.1405462 0.7388015	0.0761399 2.7766260
$^{243}\text{Cm(F)}$	0.171	0.499	$a_i:$ 0.0399160 $\lambda_i:$ 0.0124612	0.2949148 0.0291542	0.1076959 0.0790403	0.3528707 0.2351459	0.1579873 0.5644096	0.0466151 2.4299500
$^{244}\text{Cm(S)}$	0.222	0.824	$a_i:$ 0.0121445 $\lambda_i:$ 0.0124293	0.3154891 0.0274092	0.1745386 0.0323570	0.1988882 0.1300536	0.2584203 0.4049343	0.0405192 1.9302800
$^{244}\text{Cm(F)}$	0.195	0.515	$a_i:$ 0.0239603 $\lambda_i:$ 0.0124641	0.2848074 0.0289550	0.1123227 0.0857563	0.3697661 0.2523754	0.1517931 0.6463825	0.0573503 2.6003920
$^{245}\text{Cm(T)}$	0.276	0.774	$a_i:$ 0.0153146 $\lambda_i:$ 0.0124720	0.1545863 0.0293932	0.1254396 0.0944953	0.4105706 0.2721808	0.1983953 0.7272526	0.0956936 2.7912680
$^{246}\text{Cm(S)}$	0.178	0.452	$a_i:$ 0.0087992 $\lambda_i:$ 0.0124656	0.3352134 0.0286031	0.1264729 0.0938556	0.3304494 0.2825493	0.1498676 0.7615558	0.0491974 2.7614210
$^{246}\text{Cm(F)}$	0.223	0.571	$a_i:$ 0.0094310 $\lambda_i:$ 0.0124686	0.2403567 0.0287486	0.1239289 0.0957939	0.3767041 0.2817151	0.1725797 0.8232642	0.0769997 2.9611620
$^{248}\text{Cm(S)}$	0.188	0.481	$a_i:$ 0.0030983 $\lambda_i:$ 0.0124675	0.2330431 0.0285135	0.1361440 0.1002031	0.3517758 0.3040819	0.2164997 0.8408801	0.0594392 2.9554580
$^{248}\text{Cm(F)}$	0.248	0.694	$a_i:$ 0.0033366 $\lambda_i:$ 0.0124718	0.1813127 0.0286136	0.1137842 0.0997853	0.3627707 0.3014344	0.2400179 0.9116611	0.0987779 3.1496510
$^{249}\text{Cf(T)}$	0.197	0.556	$a_i:$ 0.0223428 $\lambda_i:$ 0.0124637	0.2974914 0.0288345	0.1016293 0.0889906	0.3467964 0.2904635	0.1578413 0.8704791	0.0738987 2.9351480
$^{250}\text{Cf(S)}$	0.343	1.293	$a_i:$ 0.0117318 $\lambda_i:$ 0.0124245	0.2285214 0.0272445	0.1363386 0.0333966	0.2271223 0.1384506	0.3189482 0.4277623	0.0773377 2.0887320
$^{251}\text{Cf(T)}$	0.180	0.448	$a_i:$ 0.0020060 $\lambda_i:$ 0.0124699	0.3111191 0.0284585	0.1411931 0.0971059	0.3205049 0.3059056	0.1749396 0.8478205	0.0502372 3.0230990
$^{252}\text{Cf(S)}$	0.276	0.808	$a_i:$ 0.0067872 $\lambda_i:$ 0.0124731	0.1989493 0.0288084	0.1102103 0.0941365	0.3693785 0.2902435	0.2290029 0.8564256	0.0856718 3.1219890
$^{253}\text{Es(S)}$	0.188	0.476	$a_i:$ 0.0109447 $\lambda_i:$ 0.0124651	0.3066799 0.0286474	0.1180805 0.0937368	0.3542092 0.2865770	0.1529834 0.7812261	0.0571022 2.9318090
$^{254}\text{Es(T)}$	0.233	0.599	$a_i:$ 0.0004034 $\lambda_i:$ 0.0124856	0.2961178 0.0284173	0.1353511 0.0951628	0.3299845 0.3116620	0.1865620 0.8745749	0.0515812 3.2767640
$^{254}\text{Fm(S)}$	0.119	0.317	$a_i:$ 0.0053321 $\lambda_i:$ 0.0124607	0.4742670 0.0284222	0.1376813 0.0979461	0.2582447 0.2992897	0.1010834 0.8069259	0.0233915 2.9249550
$^{255}\text{Fm(T)}$	0.136	0.414	$a_i:$ 0.0011643 $\lambda_i:$ 0.0124703	0.4714080 0.0283990	0.1674376 0.0918658	0.2052006 0.2588282	0.1372538 0.6115637	0.0175356 2.0071800
$^{256}\text{Fm(S)}$	0.131	0.347	$a_i:$ 0.0034194 $\lambda_i:$ 0.0124629	0.3978897 0.0284258	0.1464589 0.0967738	0.2860018 0.3007603	0.1372660 0.7955427	0.0289642 2.6783020

Table 10. 8-Group Parameters from Constrained STEPIT Fits to CINDER'90 Results for a Range of Fission Histories and Decay Times to 800 s

ID	Deviation, %		Time Group Parameters							
	RMS	Max	$\lambda_1:0.0124667$	$\lambda_2:0.0282917$	$\lambda_3:0.0425244$	$\lambda_4:0.1330417$	$\lambda_5:0.2924672$	$\lambda_6:0.6664877$	$\lambda_7:1.6347810$	$\lambda_8:3.5546010$
All Systems			$a_1:0.1627655$	$a_2:0.1739975$	$a_3:0.1420202$	$a_4:0.1582499$				
$^{227}\text{Th}(\text{T})$	0.183	0.669	$a_5:0.2938985$	$a_6:0.0489443$	$a_7:0.0159437$	$a_8:0.0041803$				
$^{229}\text{Th}(\text{T})$	0.190	0.679	$a_1:0.1103871$	$a_2:0.1302192$	$a_3:0.1674039$	$a_4:0.1507454$	$a_5:0.3228149$	$a_6:0.0829144$	$a_7:0.0302362$	$a_8:0.0052789$
$^{232}\text{Th}(\text{F})$	0.286	0.943	$a_1:0.0291606$	$a_2:0.0248733$	$a_3:0.0737401$	$a_4:0.1238565$	$a_5:0.4188654$	$a_6:0.1974823$	$a_7:0.0863478$	$a_8:0.0456740$
$^{232}\text{Th}(\text{H})$	0.383	1.437	$a_1:0.0197484$	$a_2:0.0377927$	$a_3:0.0469414$	$a_4:0.0826393$	$a_5:0.4570496$	$a_6:0.2011236$	$a_7:0.0689461$	$a_8:0.0857589$
$^{231}\text{Pa}(\text{F})$	0.181	0.631	$a_1:0.0772981$	$a_2:0.1390219$	$a_3:0.1407856$	$a_4:0.1674921$	$a_5:0.3646237$	$a_6:0.0647482$	$a_7:0.0334124$	$a_8:0.0126180$
$^{232}\text{U}(\text{T})$	0.186	0.679	$a_1:0.1058190$	$a_2:0.1670825$	$a_3:0.1607793$	$a_4:0.1972904$	$a_5:0.2912777$	$a_6:0.0378770$	$a_7:0.0319200$	$a_8:0.0079541$
$^{233}\text{U}(\text{T})$	0.184	0.650	$a_1:0.0712708$	$a_2:0.1535382$	$a_3:0.1251520$	$a_4:0.1646642$	$a_5:0.3366977$	$a_6:0.0963885$	$a_7:0.0263103$	$a_8:0.0259783$
$^{233}\text{U}(\text{F})$	0.178	0.656	$a_1:0.0847591$	$a_2:0.1471754$	$a_3:0.1408362$	$a_4:0.1866432$	$a_5:0.3329638$	$a_6:0.0618178$	$a_7:0.0357113$	$a_8:0.0100933$
$^{233}\text{U}(\text{H})$	0.183	0.647	$a_1:0.0609040$	$a_2:0.0744390$	$a_3:0.1265846$	$a_4:0.1585438$	$a_5:0.4055026$	$a_6:0.0934518$	$a_7:0.0550030$	$a_8:0.0255712$
$^{234}\text{U}(\text{F})$	0.174	0.627	$a_1:0.0548538$	$a_2:0.1565998$	$a_3:0.1047605$	$a_4:0.1823049$	$a_5:0.3547401$	$a_6:0.0830032$	$a_7:0.0461797$	$a_8:0.0175580$
$^{234}\text{U}(\text{H})$	0.187	0.646	$a_1:0.0669088$	$a_2:0.0777279$	$a_3:0.1196924$	$a_4:0.1453626$	$a_5:0.4159038$	$a_6:0.0987197$	$a_7:0.0512118$	$a_8:0.0244730$
$^{235}\text{U}(\text{T})$	0.236	1.204	$a_1:0.0329559$	$a_2:0.1312149$	$a_3:0.0817149$	$a_4:0.1536986$	$a_5:0.3254447$	$a_6:0.1391426$	$a_7:0.0713228$	$a_8:0.0645057$
$^{235}\text{U}(\text{F})$	0.192	0.613	$a_1:0.0314282$	$a_2:0.1012978$	$a_3:0.0873553$	$a_4:0.1549142$	$a_5:0.3871408$	$a_6:0.1278250$	$a_7:0.0627178$	$a_8:0.0473209$
$^{235}\text{U}(\text{H})$	0.197	0.644	$a_1:0.0321416$	$a_2:0.0726911$	$a_3:0.0953011$	$a_4:0.1410611$	$a_5:0.4378867$	$a_6:0.1166877$	$a_7:0.0678748$	$a_8:0.0363560$
$^{236}\text{U}(\text{F})$	0.192	0.599	$a_1:0.0247468$	$a_2:0.1379689$	$a_3:0.0735194$	$a_4:0.1580164$	$a_5:0.3395284$	$a_6:0.1432061$	$a_7:0.0776575$	$a_8:0.0453565$
$^{236}\text{U}(\text{H})$	0.179	0.624	$a_1:0.0335430$	$a_2:0.0911102$	$a_3:0.0700535$	$a_4:0.1445893$	$a_5:0.4036208$	$a_6:0.1264225$	$a_7:0.0823363$	$a_8:0.0483244$
$^{237}\text{U}(\text{F})$	0.194	0.586	$a_1:0.0147193$	$a_2:0.1333616$	$a_3:0.0635415$	$a_4:0.1468140$	$a_5:0.3343678$	$a_6:0.1685277$	$a_7:0.0826752$	$a_8:0.0559930$
$^{238}\text{U}(\text{S})$	0.199	0.591	$a_1:0.0087594$	$a_2:0.0897421$	$a_3:0.0251989$	$a_4:0.0911275$	$a_5:0.3332838$	$a_6:0.2160955$	$a_7:0.1504548$	$a_8:0.0853380$
$^{238}\text{U}(\text{F})$	0.243	0.757	$a_1:0.0100221$	$a_2:0.0893630$	$a_3:0.0378251$	$a_4:0.1186762$	$a_5:0.3301993$	$a_6:0.2196943$	$a_7:0.1145924$	$a_8:0.0796276$
$^{238}\text{U}(\text{H})$	0.261	0.807	$a_1:0.0146485$	$a_2:0.0778481$	$a_3:0.0457815$	$a_4:0.1375583$	$a_5:0.3430609$	$a_6:0.1878615$	$a_7:0.1063963$	$a_8:0.0868448$
$^{237}\text{Np}(\text{T})$	0.200	0.565	$a_1:0.0249515$	$a_2:0.1691329$	$a_3:0.0723450$	$a_4:0.1622701$	$a_5:0.3519122$	$a_6:0.1237352$	$a_7:0.0655699$	$a_8:0.0300831$
$^{237}\text{Np}(\text{F})$	0.220	0.600	$a_1:0.0309824$	$a_2:0.1371525$	$a_3:0.0800718$	$a_4:0.1633647$	$a_5:0.3730346$	$a_6:0.1224156$	$a_7:0.0615353$	$a_8:0.0314431$
$^{237}\text{Np}(\text{H})$	0.174	0.580	$a_1:0.0237762$	$a_2:0.1254921$	$a_3:0.0629939$	$a_4:0.1594906$	$a_5:0.3901432$	$a_6:0.1077102$	$a_7:0.0860192$	$a_8:0.0443745$
$^{238}\text{Np}(\text{F})$	0.221	0.659	$a_1:0.0178442$	$a_2:0.1867266$	$a_3:0.0632586$	$a_4:0.1645048$	$a_5:0.3347702$	$a_6:0.1378306$	$a_7:0.0603941$	$a_8:0.0346709$
$^{238}\text{Pu}(\text{F})$	0.177	0.595	$a_1:0.0342761$	$a_2:0.1688081$	$a_3:0.0801995$	$a_4:0.1645299$	$a_5:0.3637744$	$a_6:0.1040074$	$a_7:0.0543839$	$a_8:0.0300207$
$^{239}\text{Pu}(\text{T})$	0.274	0.855	$a_1:0.0246056$	$a_2:0.2298048$	$a_3:0.0647184$	$a_4:0.1823723$	$a_5:0.3099252$	$a_6:0.1114084$	$a_7:0.0553649$	$a_8:0.0218004$
$^{239}\text{Pu}(\text{F})$	0.240	0.713	$a_1:0.0323646$	$a_2:0.2139659$	$a_3:0.0771397$	$a_4:0.1858686$	$a_5:0.3061954$	$a_6:0.1127803$	$a_7:0.0461525$	$a_8:0.0255331$
$^{239}\text{Pu}(\text{H})$	0.203	0.642	$a_1:0.0411263$	$a_2:0.0837746$	$a_3:0.0988120$	$a_4:0.1167242$	$a_5:0.4412968$	$a_6:0.1188147$	$a_7:0.0598383$	$a_8:0.0396132$
$^{240}\text{Pu}(\text{T})$	0.205	0.562	$a_1:0.0189743$	$a_2:0.2238596$	$a_3:0.0677413$	$a_4:0.1460048$	$a_5:0.3238594$	$a_6:0.1298767$	$a_7:0.0591937$	$a_8:0.0304902$

Table 10. 8-Group Parameters from Constrained STEPIT Fits to CINDER'90 Results for a Range of Fission Histories and Decay Times to 800 s (Continued)

ID	Deviation, %		Time Group Parameters							
	RMS	Max	a ₁ :0.0206219	a ₂ :0.2129714	a ₃ :0.0597590	a ₄ :0.1562141	a ₅ :0.3302044	a ₆ :0.1300517	a ₇ :0.0590110	a ₈ :0.0311665
²⁴⁰ Pu(F)	0.203	0.551	a ₁ :0.0333552	a ₂ :0.1120110	a ₃ :0.0770788	a ₄ :0.1369968	a ₅ :0.3968256	a ₆ :0.1302093	a ₇ :0.0701452	a ₈ :0.0433781
²⁴¹ Pu(T)	0.262	0.896	a ₁ :0.0123782	a ₂ :0.2129577	a ₃ :0.0519509	a ₄ :0.1584675	a ₅ :0.3043873	a ₆ :0.1655026	a ₇ :0.0578755	a ₈ :0.0364801
²⁴¹ Pu(F)	0.223	0.709	a ₁ :0.0135061	a ₂ :0.2017616	a ₃ :0.0548943	a ₄ :0.1446280	a ₅ :0.3176521	a ₆ :0.1572925	a ₇ :0.0673046	a ₈ :0.0429608
²⁴² Pu(T)	0.254	0.883	a ₁ :0.0085965	a ₂ :0.1806941	a ₃ :0.0470857	a ₄ :0.1289220	a ₅ :0.2997325	a ₆ :0.1977370	a ₇ :0.0794364	a ₈ :0.0577959
²⁴² Pu(F)	0.249	0.830	a ₁ :0.0088803	a ₂ :0.1489843	a ₃ :0.0452820	a ₄ :0.1387895	a ₅ :0.3180996	a ₆ :0.1933721	a ₇ :0.0826574	a ₈ :0.0639347
²⁴² Pu(H)	0.274	0.931	a ₁ :0.0143407	a ₂ :0.1177746	a ₃ :0.0490191	a ₄ :0.1202900	a ₅ :0.3550937	a ₆ :0.1859045	a ₇ :0.0860061	a ₈ :0.0715713
²⁴¹ Am(T)	0.226	0.666	a ₁ :0.0235560	a ₂ :0.2615333	a ₃ :0.0641076	a ₄ :0.1668593	a ₅ :0.3139038	a ₆ :0.1077446	a ₇ :0.0423015	a ₈ :0.0199937
²⁴¹ Am(F)	0.189	0.558	a ₁ :0.0345397	a ₂ :0.2489195	a ₃ :0.0918154	a ₄ :0.1571158	a ₅ :0.3283046	a ₆ :0.0919551	a ₇ :0.0324246	a ₈ :0.0149253
²⁴¹ Am(H)	0.230	0.657	a ₁ :0.0458636	a ₂ :0.1019516	a ₃ :0.0918297	a ₄ :0.1458413	a ₅ :0.3842696	a ₆ :0.1476541	a ₇ :0.0533776	a ₈ :0.0292124
^{42m} Am(T)	0.219	0.651	a ₁ :0.0174952	a ₂ :0.2411766	a ₃ :0.0605965	a ₄ :0.1591513	a ₅ :0.3165394	a ₆ :0.1262440	a ₇ :0.0488231	a ₈ :0.0299739
²⁴³ Am(F)	0.209	0.608	a ₁ :0.0162801	a ₂ :0.2304058	a ₃ :0.0563818	a ₄ :0.1441734	a ₅ :0.3263901	a ₆ :0.1327913	a ₇ :0.0564831	a ₈ :0.0370944
²⁴² Cm(F)	0.175	0.596	a ₁ :0.0543616	a ₂ :0.2527719	a ₃ :0.0915911	a ₄ :0.1390684	a ₅ :0.3348399	a ₆ :0.0818896	a ₇ :0.0324887	a ₈ :0.0129889
²⁴³ Cm(T)	0.184	0.562	a ₁ :0.0280306	a ₂ :0.2177647	a ₃ :0.0592791	a ₄ :0.1406957	a ₅ :0.3433407	a ₆ :0.1090516	a ₇ :0.0628746	a ₈ :0.0389630
²⁴³ Cm(F)	0.174	0.574	a ₁ :0.0399627	a ₂ :0.2495936	a ₃ :0.0843160	a ₄ :0.1611472	a ₅ :0.3249463	a ₆ :0.0857061	a ₇ :0.0380927	a ₈ :0.0162352
²⁴⁴ Cm(S)	0.244	0.795	a ₁ :0.0124343	a ₂ :0.4459516	a ₃ :0.0552957	a ₄ :0.1563586	a ₅ :0.1969676	a ₆ :0.1073436	a ₇ :0.0159688	a ₈ :0.0096798
²⁴⁴ Cm(F)	0.188	0.543	a ₁ :0.0239524	a ₂ :0.2496348	a ₃ :0.0663687	a ₄ :0.1580822	a ₅ :0.3242597	a ₆ :0.1060752	a ₇ :0.0470998	a ₈ :0.0245273
²⁴⁵ Cm(T)	0.307	1.043	a ₁ :0.0152406	a ₂ :0.1248402	a ₃ :0.0538976	a ₄ :0.1642271	a ₅ :0.3443700	a ₆ :0.1759218	a ₇ :0.0695421	a ₈ :0.0519605
²⁴⁶ Cm(S)	0.263	0.905	a ₁ :0.0087922	a ₂ :0.3119636	a ₃ :0.0487911	a ₄ :0.1511479	a ₅ :0.2594060	a ₆ :0.1527219	a ₇ :0.0420042	a ₈ :0.0251732
²⁴⁶ Cm(F)	0.242	0.823	a ₁ :0.0094041	a ₂ :0.2178451	a ₃ :0.0447105	a ₄ :0.1554476	a ₅ :0.2974103	a ₆ :0.1621097	a ₇ :0.0668916	a ₈ :0.0461812
²⁴⁸ Cm(S)	0.401	1.502	a ₁ :0.0030938	a ₂ :0.2194767	a ₃ :0.0321375	a ₄ :0.1605547	a ₅ :0.2447122	a ₆ :0.2453353	a ₇ :0.0591353	a ₈ :0.0355546
²⁴⁸ Cm(F)	0.333	1.227	a ₁ :0.0033211	a ₂ :0.1677295	a ₃ :0.0295426	a ₄ :0.1372801	a ₅ :0.2604564	a ₆ :0.2357072	a ₇ :0.0991988	a ₈ :0.0667644
²⁴⁹ Cf(T)	0.210	0.640	a ₁ :0.0223455	a ₂ :0.2663782	a ₃ :0.0586952	a ₄ :0.1126051	a ₅ :0.2760520	a ₆ :0.1484293	a ₇ :0.0731919	a ₈ :0.0423028
²⁵⁰ Cf(S)	0.284	0.981	a ₁ :0.0120520	a ₂ :0.3224346	a ₃ :0.0491784	a ₄ :0.1673064	a ₅ :0.2390326	a ₆ :0.1482676	a ₇ :0.0396607	a ₈ :0.0220678
²⁵¹ Cf(T)	0.399	1.500	a ₁ :0.0020003	a ₂ :0.2963994	a ₃ :0.0374041	a ₄ :0.1631338	a ₅ :0.2141887	a ₆ :0.2103723	a ₇ :0.0435943	a ₈ :0.0329072
²⁵² Cf(S)	0.276	0.956	a ₁ :0.0067475	a ₂ :0.1779069	a ₃ :0.0422032	a ₄ :0.1359861	a ₅ :0.2771078	a ₆ :0.2228365	a ₇ :0.0803133	a ₈ :0.0568988
²⁵³ Es(S)	0.259	0.885	a ₁ :0.0109398	a ₂ :0.2832085	a ₃ :0.0479064	a ₄ :0.1389857	a ₅ :0.2833318	a ₆ :0.1575518	a ₇ :0.0435136	a ₈ :0.0345623
²⁵⁴ Es(T)	0.447	1.687	a ₁ :0.0003979	a ₂ :0.2840536	a ₃ :0.0345825	a ₄ :0.1576093	a ₅ :0.2097973	a ₆ :0.2330758	a ₇ :0.0393997	a ₈ :0.0410839
²⁵⁴ Fm(S)	0.272	0.937	a ₁ :0.0053477	a ₂ :0.4572974	a ₃ :0.0404643	a ₄ :0.1529536	a ₅ :0.1838308	a ₆ :0.1269390	a ₇ :0.0187664	a ₈ :0.0144007
²⁵⁵ Fm(T)	0.431	1.556	a ₁ :0.0011612	a ₂ :0.4548626	a ₃ :0.0488430	a ₄ :0.2082286	a ₅ :0.1343906	a ₆ :0.1441664	a ₇ :0.0028459	a ₈ :0.0055017
²⁵⁶ Fm(S)	0.367	1.338	a ₁ :0.0034257	a ₂ :0.3821999	a ₃ :0.0403403	a ₄ :0.1668464	a ₅ :0.1955793	a ₆ :0.1706188	a ₇ :0.0268587	a ₈ :0.0141309

Table 11. Comparison of Relative Delayed-Neutron Production Rates Following Fission and Asymptotic Periods Following Reactivity Steps from Equilibrium Calculated with R(t) Functions Fit to Measurements and Summation Calculations^a

System	Pulse Function	# Gp	R(t) Value at t After Fission, fraction/sec					Period T (sec) Following Step			
			t=.05s	t=.50s	t=5.0s	t=50s	t=500s	$\rho=10\text{f}$	$\rho=25\text{f}$	$\rho=40\text{f}$	$\rho=50\text{f}$
²²⁷ TH(T)	This Calc., Free λ_s	6	1.87E-01	1.44E-01	4.29E-02	3.03E-03	3.99E-06	200.07	54.92	22.48	13.29
	, Fixed λ_s	8	1.87E-01	1.44E-01	4.30E-02	3.03E-03	3.97E-06	203.20	55.31	22.59	13.34
²²⁹ TH(T)	Brady&England'89	6	2.51E-01	1.91E-01	4.77E-02	2.07E-03	2.18E-06	133.16	34.43	14.06	8.56
	This Calc., Free λ_s	6	2.40E-01	1.77E-01	4.44E-02	2.51E-03	2.71E-06	153.85	40.72	16.23	9.47
	, Fixed λ_s	8	2.40E-01	1.77E-01	4.44E-02	2.51E-03	2.69E-06	154.73	40.84	16.26	9.48
	Brady&England'89	6	2.69E-01	2.05E-01	4.92E-02	1.80E-03	1.84E-06	113.22	28.61	11.49	6.91
²³² TH(F)	Gudkov+'89	5	1.75E-01	1.39E-01	4.22E-02	3.13E-03	2.83E-06	188.75	53.00	21.93	12.80
	" w/ Ref $\bar{\nu}$ & β							190.93	53.71	22.44	13.27
	This Calc., Free λ_s	6	5.33E-01	3.11E-01	4.52E-02	7.54E-04	7.16E-07	51.75	13.13	5.52	3.38
	, Fixed λ_s	8	5.34E-01	3.10E-01	4.51E-02	7.61E-04	7.12E-07	51.65	13.12	5.52	3.38
	Brady&England'89	6	5.09E-01	2.97E-01	4.38E-02	1.05E-03	6.82E-07	62.87	15.47	6.25	3.74
	Brolley+'43	4	3.07E-01	2.48E-01	4.07E-02	1.56E-03	1.52E-06	94.42	23.16	8.93	5.19
	" w/ Ref $\bar{\nu}$ & β							94.21	23.12	8.91	5.17
	Crevelling+'49	5	1.21E+00	2.39E-01	3.74E-02	1.24E-03	9.96E-07	71.00	16.27	5.90	3.23
	" w/ Ref $\bar{\nu}$ & β							70.84	16.22	5.87	3.21
	Rose&Smith'57	5	4.16E-01	2.84E-01	4.47E-02	1.12E-03	8.08E-07	69.39	17.27	7.00	4.20
	" w/ Ref $\bar{\nu}$ & β							69.24	17.23	6.98	4.18
	Keepin+'57	6	4.81E-01	2.86E-01	4.41E-02	1.21E-03	8.66E-07	71.14	17.57	7.00	4.15
	" w/ Ref $\bar{\nu}$ & β							70.99	17.53	6.98	4.13
	Waldo+'81	5	4.69E-01	2.94E-01	4.22E-02	1.19E-03	8.65E-07	72.07	17.78	7.04	4.15
	" w/ Ref $\bar{\nu}$ & β							71.93	17.74	7.02	4.13
²³² TH(H)	This Calc., Free λ_s	6	6.33E-01	3.28E-01	4.45E-02	6.36E-04	4.85E-07	45.16	11.86	5.25	3.37
	, Fixed λ_s	8	6.34E-01	3.27E-01	4.42E-02	6.45E-04	4.83E-07	45.04	11.85	5.25	3.37
	Brady&England'89	6	5.37E-01	2.97E-01	4.63E-02	8.55E-04	6.37E-07	56.65	14.56	6.27	3.96
	Sun+'50	5	2.32E-01	1.68E-01	4.05E-02	2.88E-03	3.46E-06	178.69	48.49	19.54	11.33
	" w/ Ref $\bar{\nu}$ & β							178.02	48.39	19.51	11.31
	Hermann+'65	4	2.00E-01	1.75E-01	5.15E-02	1.91E-03	1.62E-06	119.53	31.59	13.04	7.92
	" w/ Ref $\bar{\nu}$ & β							119.07	31.52	13.02	7.91
	Hermann'67	6	6.48E-01	2.88E-01	3.62E-02	1.75E-03	1.52E-06	100.39	23.96	8.87	5.04
	" w/ Ref $\bar{\nu}$ & β							99.98	23.90	8.84	5.03
	Notea'69	5	9.88E-02	9.27E-02	5.18E-02	2.53E-03	1.01E-06	152.11	45.82	21.03	13.40
	" w/ Ref $\bar{\nu}$ & β							151.56	45.74	21.00	13.38
	Brown+'71	4	1.64E-01	1.45E-01	5.10E-02	2.18E-03	1.76E-06	136.17	37.72	16.08	9.83
	" w/ Ref $\bar{\nu}$ & β							135.66	37.65	16.05	9.81
	Benedict+'72	6	6.72E-01	2.56E-01	3.98E-02	1.55E-03	1.73E-06	93.74	22.84	8.83	5.16
	" w/ Ref $\bar{\nu}$ & β							93.35	22.79	8.81	5.14
	Maksyutenko+'58	5	4.01E-01	2.78E-01	4.38E-02	1.29E-03	9.03E-07	78.60	20.03	8.24	5.03
	" w/ Ref $\bar{\nu}$ & β							77.84	19.90	8.18	4.99
²³¹ PA(F)	This Calc., Free λ_s	6	2.67E-01	1.87E-01	4.69E-02	2.22E-03	1.89E-06	132.05	34.96	14.17	8.43
	, Fixed λ_s	8	2.68E-01	1.86E-01	4.69E-02	2.22E-03	1.89E-06	131.45	34.89	14.15	8.42
	Brady&England'89	6	2.87E-01	2.02E-01	4.70E-02	1.98E-03	1.68E-06	119.55	31.20	12.62	7.55
	Chrysochoides+'70	3	3.08E-02	3.03E-02	2.59E-02	6.05E-03	5.59E-06	353.81	113.48	54.73	35.72
	" w/ Ref $\bar{\nu}$ & β							353.81	113.92	55.16	36.14
	Anoussis+'73	6	1.54E-01	1.37E-01	4.83E-02	2.63E-03	2.90E-06	162.58	44.38	18.24	10.77
	" w/ Ref $\bar{\nu}$ & β							163.30	45.03	18.80	11.30
²³² U(T)	This Calc., Free λ_s	6	2.19E-01	1.57E-01	4.49E-02	2.71E-03	2.59E-06	171.46	48.72	21.39	13.57
	, Fixed λ_s	8	2.19E-01	1.57E-01	4.50E-02	2.70E-03	2.58E-06	177.09	49.41	21.58	13.66
	Brady&England'89	6	2.29E-01	1.67E-01	4.33E-02	2.66E-03	2.89E-06	179.86	49.44	21.31	13.40
	Waldo+'81	5	1.76E-01	1.48E-01	4.59E-02	2.66E-03	2.59E-06	163.85	44.54	18.15	10.62
	" w/ Ref $\bar{\nu}$ & β							177.05	49.50	21.74	13.83
²³³ U(T)	This Calc., Free λ_s	6	3.08E-01	1.97E-01	4.52E-02	2.19E-03	1.75E-06	130.77	35.06	14.56	8.92
	, Fixed λ_s	8	3.08E-01	1.97E-01	4.53E-02	2.20E-03	1.74E-06	132.86	35.31	14.63	8.95
	Brady&England'89	6	6.31E-01	3.05E-01	3.59E-02	1.72E-03	1.37E-06	101.11	24.71	9.72	5.89
	Cahn+'45	5	2.99E-01	2.10E-01	4.41E-02	2.08E-03	1.84E-06	126.66	34.10	14.27	8.83
	" w/ Ref $\bar{\nu}$ & β							130.33	34.32	14.19	8.70
	Girshfeld'55	4	1.83E-01	1.57E-01	4.66E-02	2.50E-03	2.12E-06	152.20	42.49	18.07	11.16
	" w/ Ref $\bar{\nu}$ & β							156.58	42.82	18.03	11.05
	Keepin+'57	6	2.64E-01	1.78E-01	4.50E-02	2.48E-03	1.99E-06	145.68	40.66	17.27	10.63
	" w/ Ref $\bar{\nu}$ & β							149.87	40.97	17.22	10.52
	Rambo'69	5	2.55E-01	1.70E-01	4.57E-02	2.43E-03	1.52E-06	145.54	41.14	17.68	10.95
	" w/ Ref $\bar{\nu}$ & β							149.70	41.45	17.63	10.84
	Onega+'69	5	2.57E-01	1.72E-01	4.68E-02	2.28E-03	1.38E-06	138.32	39.17	16.98	10.59
	" w/ Ref $\bar{\nu}$ & β							142.26	39.45	16.92	10.48
	Waldo+'81	6	2.65E-01	1.90E-01	4.51E-02	2.38E-03	1.91E-06	139.34	38.62	16.37	10.10
	" w/ Ref $\bar{\nu}$ & β							143.34	38.90	16.31	9.98
²³³ U(F)	This Calc., Free λ_s	6	2.55E-01	1.80E-01	4.62E-02	2.33E-03	2.08E-06	142.55	38.63	16.17	9.91
	, Fixed λ_s	8	2.56E-01	1.80E-01	4.63E-02	2.32E-03	2.07E-06	140.99	38.46	16.13	9.89
	Brady&England'89	6	3.04E-01	2.06E-01	4.52E-02	2.04E-03	1.75E-06	124.50	33.27	13.88	8.56

Table 11. Comparison of Relative Delayed-Neutron Production Rates Following Fission and Asymptotic Periods Following Reactivity Steps from Equilibrium Calculated with R(t) Functions Fit to Measurements and Summation Calculations^a (Continued)

System	Pulse Function	# Gp	R(t) Value at t After Fission, fraction/sec					Period T (sec) Following Step			
			t=.05s	t=.50s	t=5.0s	t=50s	t=500s	$\rho=10t$	$\rho=25t$	$\rho=40t$	$\rho=50t$
²³³ U(F) (continued)	Rose&Smith'57 " w/ Ref $\bar{\nu}$ & β	5	2.16E-01	1.68E-01	4.62E-02	2.41E-03	1.96E-06	149.57 146.10	41.11 40.52	17.46 17.19	10.79 10.59
	Keepin+'57 " w/ Ref $\bar{\nu}$ & β	6	2.83E-01	1.85E-01	4.55E-02	2.34E-03	2.01E-06	144.13 140.74	39.14 38.56	16.46 16.20	10.12 9.93
	Benedetti+'82 " w/ Ref $\bar{\nu}$ & β	5	2.71E-01	1.92E-01	4.42E-02	2.37E-03	1.98E-06	144.47 141.06	39.24 38.66	16.48 16.22	10.11 9.91
	Gudkov+'89 " w/ Ref $\bar{\nu}$ & β	6	2.89E-01	1.87E-01	4.49E-02	2.36E-03	1.98E-06	144.76 141.36	39.36 38.78	16.55 16.28	10.17 9.97
²³³ U(H)	This Calc., Free λ_s , Fixed λ_s	6	3.64E-01	2.31E-01	4.74E-02	1.59E-03	1.49E-06	107.95	29.94	13.78	9.26
	Brady&England'89	6	3.65E-01	2.30E-01	4.75E-02	1.59E-03	1.49E-06	106.92	29.83	13.75	9.25
	East+'70 " w/ Ref $\bar{\nu}$ & β	6	3.21E-01	2.16E-01	4.63E-02	1.80E-03	1.91E-06	122.61	34.00	15.40	10.22
²³⁴ U(F)	This Calc., Free λ_s , Fixed λ_s	6	3.11E-01	2.06E-01	4.65E-02	2.01E-03	1.35E-06	117.19	30.97	12.67	7.64
	Brady&England'89	6	3.11E-01	2.05E-01	4.66E-02	2.01E-03	1.34E-06	116.75	30.93	12.66	7.64
	Brady&England'89	6	3.54E-01	2.32E-01	4.62E-02	1.65E-03	1.03E-06	98.15	25.57	10.54	6.44
²³⁴ U(H)	This Calc., Free λ_s , Fixed λ_s	6	3.60E-01	2.31E-01	4.72E-02	1.61E-03	1.64E-06	105.43	27.93	12.19	7.90
	Brady&England'89	6	3.61E-01	2.30E-01	4.73E-02	1.61E-03	1.63E-06	108.94	28.33	12.29	7.95
	Brady&England'89	6	3.38E-01	2.26E-01	4.63E-02	1.70E-03	1.72E-06	115.43	30.11	13.00	8.35
²³⁵ U(T)	This Calc., Free λ_s , Fixed λ_s	6	5.12E-01	2.65E-01	4.23E-02	1.55E-03	8.11E-07	87.45	22.03	8.78	5.26
	Brady&England'89	6	5.10E-01	2.66E-01	4.23E-02	1.56E-03	8.06E-07	86.87	21.96	8.77	5.25
	Snell+'42 " w/ Ref $\bar{\nu}$ & β	4	5.24E-01	2.83E-01	4.01E-02	1.53E-03	6.54E-07	84.04	21.07	8.34	4.98
	Redman&Saxon'44-7 " w/ Ref $\bar{\nu}$ & β	4	1.35E-01	1.22E-01	5.15E-02	2.42E-03	1.07E-06	143.86 143.55	41.77 41.70	18.39 18.35	11.43 11.40
	deHoffmann+'45 " w/ Ref $\bar{\nu}$ & β	5	2.90E-01	1.92E-01	4.35E-02	2.37E-03	1.30E-06	134.47 133.84	36.79 36.68	15.11 15.06	8.96 8.92
	Hughes+'45,48 " w/ Ref $\bar{\nu}$ & β	5	3.72E-01	2.52E-01	4.28E-02	1.74E-03	8.13E-07	96.53 96.05	24.91 24.81	10.02 9.96	6.00 5.96
	Snell+'46,7 " w/ Ref $\bar{\nu}$ & β	5	3.27E-01	2.04E-01	4.29E-02	2.45E-03	1.14E-06	134.52 133.92	36.72 36.60	14.95 14.90	8.81 8.76
	Girshfeld'55 " w/ Ref $\bar{\nu}$ & β	4	2.28E-01	1.93E-01	4.80E-02	1.97E-03	9.23E-07	111.57 111.03	29.99 29.88	12.42 12.37	7.54 7.50
	Keepin+'57 " w/ Ref $\bar{\nu}$ & β	6	3.78E-01	2.32E-01	4.55E-02	1.76E-03	8.18E-07	100.09 99.60	26.38 26.28	10.78 10.73	6.49 6.45
	Maksyutenko+'58 " w/ Ref $\bar{\nu}$ & β	5	2.86E-01	2.06E-01	4.80E-02	1.94E-03	9.51E-07	110.31 109.80	29.73 29.63	12.33 12.27	7.46 7.42
	Rambo'69 " w/ Ref $\bar{\nu}$ & β	5	3.57E-01	2.32E-01	4.68E-02	1.69E-03	5.21E-07	95.43 94.96	25.57 25.48	10.61 10.56	6.45 6.41
	Oneaga+'69 " w/ Ref $\bar{\nu}$ & β	5	3.65E-01	2.35E-01	4.70E-02	1.60E-03	4.97E-07	92.39 91.93	24.82 24.73	10.37 10.32	6.32 6.28
	Chrysochoides+'70 " w/ Ref $\bar{\nu}$ & β	3	3.22E-02	3.17E-02	2.71E-02	6.13E-03	2.65E-06	314.04 312.91	102.49 102.30	50.37 50.29	33.32 33.27
	Schussler+'72 " w/ Ref $\bar{\nu}$ & β	6	3.92E-01	2.33E-01	4.46E-02	1.80E-03	9.27E-07	102.73 102.24	26.96 26.86	10.94 10.89	6.56 6.51
	Waldo+'81 " w/ Ref $\bar{\nu}$ & β	5	4.79E-01	2.65E-01	4.34E-02	1.65E-03	7.73E-07	92.94 92.47	23.97 23.88	9.63 9.58	5.75 5.71
	Synetos+'83 " w/ Ref $\bar{\nu}$ & β	5	2.84E-01	2.19E-01	4.60E-02	1.83E-03	9.35E-07	104.22 103.73	27.81 27.71	11.48 11.43	6.96 6.91
	Gudkov+'89 " w/ Ref $\bar{\nu}$ & β	5	2.74E-01	2.08E-01	4.73E-02	1.91E-03	8.95E-07	109.20 108.68	29.32 29.22	12.13 12.07	7.34 7.30
	Saleh+'97 " w/ Ref $\bar{\nu}$ & β	5	2.69E-01	2.07E-01	4.80E-02	1.80E-03	8.95E-07	102.38 101.89	28.11 28.01	11.89 11.84	7.28 7.24
²³⁵ U(F)	This Calc., Free λ_s , Fixed λ_s	6	4.55E-01	2.60E-01	4.57E-02	1.37E-03	7.72E-07	80.63	20.65	8.51	5.21
	Brady&England'89	6	4.56E-01	2.59E-01	4.58E-02	1.38E-03	7.69E-07	80.41	20.63	8.51	5.21
	Keepin+'55 " w/ Ref $\bar{\nu}$ & β	6	4.22E-01	2.41E-01	4.53E-02	1.66E-03	7.78E-07	95.29	24.79	10.11	6.10
	Rose&Smith'57 " w/ Ref $\bar{\nu}$ & β	5	3.22E-01	2.30E-01	4.56E-02	1.72E-03	8.57E-07	99.64 98.61	26.17 25.99	10.76 10.68	6.53 6.47
	Keepin+'57 " w/ Ref $\bar{\nu}$ & β	6	4.03E-01	2.39E-01	4.53E-02	1.71E-03	8.38E-07	98.00 96.98	25.51 25.33	10.39 10.30	6.26 6.20
	Basant+'77 " w/ Ref $\bar{\nu}$ & β	6	4.04E-01	2.30E-01	4.42E-02	1.77E-03	6.85E-07	99.35 98.34	26.20 26.02	10.73 10.64	6.46 6.40
	Gudkov+'89 " w/ Ref $\bar{\nu}$ & β	6	4.43E-01	2.59E-01	4.40E-02	1.56E-03	9.48E-07	93.09 90.91	24.55 23.17	10.41 9.34	6.57 5.62
	Loaiza+'97 " w/ Ref $\bar{\nu}$ & β	6	3.70E-01	2.24E-01	4.55E-02	1.86E-03	8.66E-07	107.27 105.24	29.25 27.91	12.46 11.39	7.79 6.82

Table 11. Comparison of Relative Delayed-Neutron Production Rates Following Fission
and Asymptotic Periods Following Reactivity Steps from Equilibrium
Calculated with R(t) Functions Fit to Measurements and Summation Calculations^a (Continued)

System	Pulse Function	# Gp	R(t) Value at t After Fission, fraction/sec					Period T (sec) Following Step			
			t=.05s	t=.50s	t=5.0s	t=50s	t=500s	$\rho=10\ell$	$\rho=25\ell$	$\rho=40\ell$	$\rho=50\ell$
²³⁵ U(F) (continued)	Charlton'98 " w/ Ref $\bar{\nu}$ & β	6	3.07E-01	2.31E-01	4.52E-02	1.75E-03	7.91E-07	98.81 98.67	26.15 26.11	10.77 10.74	6.53 6.50
	Piksaikin+'97 " w/ Ref $\bar{\nu}$ & β	6	5.14E-01	2.51E-01	4.44E-02	1.70E-03	7.73E-07	94.41 94.84	24.52 24.57	9.86 9.87	5.87 5.88
	Piksaikin+'97 " w/ Ref $\bar{\nu}$ & β	8	3.76E-01	2.30E-01	4.53E-02	1.80E-03	8.11E-07	100.57 101.03	26.63 26.68	10.88 10.89	6.54 6.55
	Piksaikin+'97 " w/ Ref $\bar{\nu}$ & β	6	4.36E-01	2.60E-01	4.30E-02	1.71E-03	8.12E-07	95.97 95.84	24.92 24.90	10.03 10.02	5.98 5.97
	Piksaikin+'97 " w/ Ref $\bar{\nu}$ & β	8	3.88E-01	2.34E-01	4.46E-02	1.80E-03	8.36E-07	101.10 100.96	26.62 26.60	10.83 10.82	6.50 6.49
	This Calc., Free λ_s , Fixed λ_s	6	4.36E-01	2.62E-01	4.75E-02	1.22E-03	7.89E-07	78.90	21.43	9.69	6.42
²³⁵ U(H)	" w/ Ref $\bar{\nu}$ & β	8	4.37E-01	2.61E-01	4.76E-02	1.22E-03	7.85E-07	79.85	21.55	9.72	6.43
	Brady&England'89	6	3.98E-01	2.50E-01	4.68E-02	1.37E-03	8.58E-07	88.65	23.89	10.63	6.96
	Hahn'64 " w/ Ref $\bar{\nu}$ & β	4	6.96E-02	6.39E-02	3.16E-02	4.23E-03	2.49E-05	462.10 462.28	137.14 137.61	59.58 60.06	35.68 36.17
	East+'70 " w/ Ref $\bar{\nu}$ & β	6	4.47E-01	2.46E-01	4.45E-02	1.61E-03	1.27E-06	99.61 101.77	26.68 26.91	11.57 11.62	7.43 7.44
	Auguston+'69 " w/ Ref $\bar{\nu}$ & β	6	4.85E-01	2.49E-01	4.42E-02	1.60E-03	9.16E-07	97.89 100.02	26.19 26.42	11.34 11.38	7.27 7.29
	Maksyutenko+'58 " w/ Ref $\bar{\nu}$ & β	5	1.19E-01	1.09E-01	5.05E-02	2.61E-03	1.18E-06	155.04 158.18	46.92 47.29	21.76 21.85	14.13 14.17
²³⁶ U(F)	This Calc., Free λ_s , Fixed λ_s	6	4.69E-01	2.65E-01	4.34E-02	1.51E-03	6.09E-07	83.65	21.20	8.47	5.05
	Brady&England'89	6	4.75E-01	2.78E-01	4.29E-02	1.36E-03	4.99E-07	76.97	19.36	7.79	4.68
	Gudkov+'89 " w/ Ref $\bar{\nu}$ & β	6	3.87E-01	2.60E-01	4.62E-02	1.41E-03	6.48E-07	83.38	22.27	9.72	6.26
²³⁶ U(H)	This Calc., Free λ_s , Fixed λ_s	6	4.90E-01	2.75E-01	4.52E-02	1.22E-03	8.24E-07	75.80	19.53	8.35	5.30
	Brady&England'89	6	4.53E-01	2.69E-01	4.49E-02	1.31E-03	8.21E-07	79.80	20.74	8.81	5.57
²³⁷ U(F)	This Calc., Free λ_s , Fixed λ_s	6	5.21E-01	2.84E-01	4.23E-02	1.36E-03	3.63E-07	73.36	18.42	7.31	4.34
	Brady&England'89	6	5.22E-01	2.83E-01	4.24E-02	1.36E-03	3.62E-07	73.42	18.43	7.32	4.34
²³⁸ U(S)	This Calc., Free λ_s , Fixed λ_s	6	7.31E-01	3.62E-01	3.71E-02	8.13E-04	2.16E-07	45.48	10.93	4.41	2.65
²³⁸ U(F)	This Calc., Free λ_s , Fixed λ_s	6	6.65E-01	3.38E-01	3.93E-02	8.87E-04	2.48E-07	50.93	12.51	5.08	3.07
	Brady&England'89	6	6.66E-01	3.38E-01	3.94E-02	8.94E-04	2.46E-07	50.97	12.52	5.09	3.07
	Keepin+'55 " w/ Ref $\bar{\nu}$ & β	6	6.32E-01	3.40E-01	3.91E-02	8.68E-04	2.11E-07	50.25	12.39	5.07	3.08
	Rose&Smith'57 " w/ Ref $\bar{\nu}$ & β	5	4.86E-01	3.16E-01	4.08E-02	1.15E-03	3.07E-07	62.40	15.51	6.23	3.74
	Keepin+'57 " w/ Ref $\bar{\nu}$ & β	6	7.41E-01	3.54E-01	3.89E-02	7.43E-04	1.52E-07	44.89 45.04	11.29 11.29	4.65 4.64	2.82 2.81
	Basant+'77 " w/ Ref $\bar{\nu}$ & β	6	8.00E-01	3.33E-01	3.86E-02	1.04E-03	2.34E-07	56.05 56.25	13.60 13.60	5.39 5.38	3.20 3.19
	Waldo+'81 " w/ Ref $\bar{\nu}$ & β	6	6.63E-01	3.43E-01	3.86E-02	9.54E-04	2.49E-07	53.31 53.49	13.13 13.13	5.27 5.26	3.16 3.14
	This Calc., Free λ_s , Fixed λ_s	6	6.60E-01	3.27E-01	4.08E-02	8.82E-04	3.61E-07	54.20	13.82	5.87	3.70
	Brady&England'89	6	6.60E-01	3.27E-01	4.08E-02	8.90E-04	3.59E-07	54.03	13.80	5.87	3.70
	Sun+'50 " w/ Ref $\bar{\nu}$ & β	5	3.73E-01	2.43E-01	4.02E-02	2.15E-03	7.99E-07	113.66 112.60	29.74 29.62	11.71 11.68	6.83 6.82
²³⁸ U(H)	Hermann+'65 " w/ Ref $\bar{\nu}$ & β	4	1.84E-01	1.62E-01	5.18E-02	2.01E-03	8.04E-07	118.01 116.95	32.96 32.83	14.15 14.12	8.73 8.72
	Hermann+'67 " w/ Ref $\bar{\nu}$ & β	6	6.05E-01	2.98E-01	3.97E-02	1.33E-03	6.20E-07	77.10 76.36	19.41 19.33	7.79 7.77	4.68 4.68
	Notea'69 " w/ Ref $\bar{\nu}$ & β	5	1.29E-01	1.17E-01	5.26E-02	2.33E-03	5.21E-07	133.64 132.47	39.86 39.72	18.08 18.04	11.44 11.43
	Bucko'66 " w/ Ref $\bar{\nu}$ & β	5	4.42E-01	3.11E-01	4.08E-02	1.18E-03	6.04E-07	66.37 65.48	16.65 16.54	6.92 6.88	4.31 4.29
	East+'70 " w/ Ref $\bar{\nu}$ & β	6	7.09E-01	3.27E-01	3.97E-02	1.01E-03	4.45E-07	58.88 58.09	14.66 14.56	6.07 6.04	3.76 3.75
	Brown+'71 " w/ Ref $\bar{\nu}$ & β	4	1.57E-01	1.41E-01	5.39E-02	2.13E-03	1.09E-06	128.28 126.72	36.08 35.88	15.65 15.59	9.72 9.69
	Benedict+'72 " w/ Ref $\bar{\nu}$ & β	6	6.24E-01	2.77E-01	4.26E-02	1.16E-03	7.57E-07	70.92 70.00	18.24 18.12	7.57 7.53	4.64 4.63
	Auguston+'69 " w/ Ref $\bar{\nu}$ & β	6	6.59E-01	3.15E-01	4.04E-02	1.12E-03	4.63E-07	64.44 63.58	16.07 15.96	6.60 6.57	4.06 4.04
	Maksyutenko+'58 " w/ Ref $\bar{\nu}$ & β	5	4.01E-01	2.83E-01	4.46E-02	1.26E-03	5.65E-07	74.14 73.18	19.02 18.90	7.95 7.91	4.94 4.92

Table 11. Comparison of Relative Delayed-Neutron Production Rates Following Fission
and Asymptotic Periods Following Reactivity Steps from Equilibrium
Calculated with R(t) Functions Fit to Measurements and Summation Calculations^a (Continued)

System	Pulse Function	# Gp	R(t) Value at t After Fission, fraction/sec					Period T (sec) Following Step			
			t=.05s	t=.50s	t=5.0s	t=50s	t=500s	$\rho=10\text{f}$	$\rho=25\text{f}$	$\rho=40\text{f}$	$\rho=50\text{f}$
²³⁸ U(H) (continued)	Maksyutenko+'65 " w/ Ref $\bar{\nu}$ & β	6	5.17E-01	3.29E-01	4.10E-02	1.07E-03	4.32E-07	62.46 61.63	15.75 15.65	6.58 6.55	4.10 4.08
	This Calc., Free λ s , Fixed λ s	6 8	3.98E-01 3.99E-01	2.43E-01 2.42E-01	4.48E-02 4.49E-02	1.72E-03 1.73E-03	6.14E-07 6.12E-07	95.76 95.56	25.26 25.24	10.47 10.47	6.45 6.45
²³⁷ NP(T)	This Calc., Free λ s , Fixed λ s	6 8	4.01E-01 4.02E-01	2.45E-01 2.44E-01	4.59E-02 4.59E-02	1.58E-03 1.58E-03	7.62E-07 7.59E-07	91.57 92.16	24.02 24.09	10.06 10.08	6.25 6.27
	Brady&England'89	6	4.12E-01	2.52E-01	4.27E-02	1.73E-03	6.89E-07	97.65	25.31	10.36	6.34
²³⁷ NP(F)	Waldo+'81 " w/ Ref $\bar{\nu}$ & β	6	3.47E-01	2.31E-01	4.51E-02	1.94E-03	8.12E-07	104.51 107.82	27.32 28.73	10.82 11.88	6.30 7.25
	Benedetti+'82 " w/ Ref $\bar{\nu}$ & β	5	1.82E-01	1.58E-01	5.13E-02	2.23E-03	1.01E-06	125.55 128.93	34.61 35.98	14.43 15.45	8.66 9.58
²³⁸ NP(F)	Gudkov+'89 " w/ Ref $\bar{\nu}$ & β	6	3.80E-01	2.37E-01	4.40E-02	1.85E-03	1.05E-06	108.19 106.10	28.66 27.77	12.04 11.40	7.52 6.96
	Saleh+'97 " w/ Ref $\bar{\nu}$ & β	5	3.00E-01	2.32E-01	4.19E-02	1.91E-03	8.35E-07	114.04 107.13	33.97 28.53	16.06 11.78	10.90 7.18
²³⁷ NP(F)	Loaiza'97 " w/ Ref $\bar{\nu}$ & β	6	3.82E-01	2.31E-01	4.24E-02	1.98E-03	8.44E-07	118.63 111.90	35.00 29.51	16.37 12.02	11.05 7.26
	Charlton'98 " w/ Ref $\bar{\nu}$ & β	6	2.54E-01	2.07E-01	4.75E-02	1.86E-03	7.93E-07	113.63 106.73	34.08 28.72	16.29 12.11	11.14 7.51
²³⁷ NP(F)	Charlton'98 " w/ Ref $\bar{\nu}$ & β	7	3.21E-01	2.25E-01	4.60E-02	1.76E-03	7.74E-07	108.43 101.25	32.30 26.86	15.42 11.23	10.57 6.95
	Maksyutenko+'74 " w/ Ref $\bar{\nu}$ & β	4	1.92E-01	1.70E-01	5.43E-02	1.81E-03	6.64E-07	116.35 109.64	35.55 30.34	17.25 13.19	11.87 8.32
²³⁷ NP(H)	Maksyutenko+'74 " w/ Ref $\bar{\nu}$ & β	4	1.95E-01	1.72E-01	5.42E-02	1.82E-03	6.24E-07	115.69 108.96	35.32 30.10	17.12 13.06	11.78 8.23
	Piksaikin+'97 " w/ Ref $\bar{\nu}$ & β	6	3.38E-01	2.12E-01	4.65E-02	2.09E-03	8.41E-07	121.23 114.70	36.41 31.05	17.20 12.93	11.64 7.89
²³⁸ NP(F)	Piksaikin+'97 " w/ Ref $\bar{\nu}$ & β	8	4.00E-01	2.33E-01	4.42E-02	2.00E-03	7.42E-07	116.39 109.61	34.73 29.31	16.38 12.08	11.09 7.33
	Maksyutenko+'74 " w/ Ref $\bar{\nu}$ & β	4	1.88E-01	1.66E-01	5.38E-02	1.90E-03	6.80E-07	120.08 113.55	36.70 31.51	17.74 13.66	12.17 8.59
²³⁷ NP(H)	This Calc., Free λ s , Fixed λ s	6 8	4.70E-01 4.71E-01	2.66E-01 2.65E-01	4.53E-02 4.55E-02	1.36E-03 1.37E-03	5.85E-07 5.83E-07	86.12 86.90	24.01 24.11	11.07 11.10	7.45 7.46
	Brady&England'89	6	4.83E-01	2.80E-01	4.37E-02	1.28E-03	5.62E-07	83.16	22.95	10.60	7.15
²³⁸ NP(F)	This Calc., Free λ s , Fixed λ s	6 8	4.08E-01 4.09E-01	2.44E-01 2.44E-01	4.42E-02 4.42E-02	1.74E-03 1.75E-03	4.41E-07 4.39E-07	94.09 94.16	24.48 24.50	9.86 9.87	5.90 5.90
	Brady&England'89	6	5.02E-01	2.83E-01	4.18E-02	1.41E-03	3.28E-07	77.42	19.54	7.86	4.75
²³⁸ PU(F)	This Calc., Free λ s , Fixed λ s	6 8	3.73E-01 3.73E-01	2.29E-01 2.28E-01	4.56E-02 4.57E-02	1.82E-03 1.82E-03	8.43E-07 8.39E-07	109.09 110.91	30.31 30.54	13.54 13.60	8.88 8.90
	Brady&England'89	6	3.77E-01	2.38E-01	4.33E-02	1.88E-03	6.50E-07	111.60	30.73	13.61	8.87
²³⁹ PU(T)	Benedetti+'82:5gp " w/ Ref $\bar{\nu}$ & β	5	2.33E-01	1.82E-01	4.60E-02	2.32E-03	8.63E-07	137.64 141.55	38.41 40.04	16.61 17.79	10.43 11.45
	This Calc., Free λ s , Fixed λ s	6 8	3.42E-01 3.43E-01	2.18E-01 2.17E-01	4.44E-02 4.44E-02	2.09E-03 2.11E-03	6.07E-07 6.05E-07	115.95 116.00	32.03 32.05	13.72 13.72	8.61 8.61
²³⁹ PU(T)	Brady&England'89	6	3.56E-01	2.28E-01	4.28E-02	2.03E-03	5.29E-07	113.02	31.07	13.27	8.33
	Redman+'44,7 " w/ Ref $\bar{\nu}$ & β	4	2.75E-01	2.18E-01	4.06E-02	2.17E-03	6.84E-07	120.53 118.77	33.25 32.91	14.23 14.06	8.93 8.79
²³⁹ PU(T)	Feld+'45 " w/ Ref $\bar{\nu}$ & β	4	2.41E-01	1.93E-01	4.17E-02	2.23E-03	9.44E-07	131.71 129.84	37.11 36.75	16.17 15.99	10.18 10.04
	Keepin+'57 " w/ Ref $\bar{\nu}$ & β	6	3.35E-01	2.10E-01	4.34E-02	2.28E-03	7.57E-07	128.07 126.22	35.45 35.10	15.14 14.96	9.45 9.31
²³⁹ PU(T)	Huizinga'68 " w/ Ref $\bar{\nu}$ & β	5	3.07E-01	2.07E-01	4.44E-02	2.19E-03	1.63E-06	133.76 131.84	36.32 35.95	15.43 15.25	9.63 9.49
	Oneaga+'69 " w/ Ref $\bar{\nu}$ & β	5	3.18E-01	2.08E-01	4.44E-02	2.19E-03	1.63E-06	133.71 131.77	36.29 35.92	15.41 15.23	9.61 9.47
²³⁹ PU(F)	Waldo+'81 " w/ Ref $\bar{\nu}$ & β	6	3.33E-01	2.30E-01	4.27E-02	2.16E-03	6.64E-07	118.78 117.04	32.71 32.36	13.98 13.81	8.76 8.63
	This Calc., Free λ s , Fixed λ s	6 8	3.40E-01 3.41E-01	2.13E-01 2.13E-01	4.45E-02 4.45E-02	2.10E-03 2.11E-03	7.96E-07 7.94E-07	118.56 119.83	32.69 32.85	14.00 14.05	8.80 8.82
²³⁹ PU(F)	Brady&England'89	6	3.85E-01	2.40E-01	4.24E-02	1.88E-03	6.26E-07	107.78	29.12	12.43	7.84
	Perry+'46 " w/ Ref $\bar{\nu}$ & β	5	1.33E+00	5.46E-01	2.17E-02	2.00E-04	2.62E-08	22.56 22.47	6.94 6.81	3.62 3.52	2.64 2.55
²³⁹ PU(F)	Keepin+'55 " w/ Ref $\bar{\nu}$ & β	6	3.67E-01	2.24E-01	4.40E-02	2.09E-03	7.54E-07	118.07 119.22	32.61 32.59	13.99 13.88	8.80 8.69
	Rose&Smith'57 " w/ Ref $\bar{\nu}$ & β	5	2.71E-01	2.01E-01	4.48E-02	2.21E-03	7.60E-07	122.28 123.48	34.50 34.49	15.02 14.92	9.50 9.39
²³⁹ PU(F)	Keepin+'57 " w/ Ref $\bar{\nu}$ & β	6	3.63E-01	2.20E-01	4.37E-02	2.13E-03	7.78E-07	118.93 120.10	32.89 32.88	14.11 14.00	8.87 8.76
	Besant+'77 " w/ Ref $\bar{\nu}$ & β	6	3.51E-01	2.16E-01	4.41E-02	2.22E-03	6.97E-07	122.21 123.42	34.06 34.05	14.62 14.52	9.17 9.06

Table 11. Comparison of Relative Delayed-Neutron Production Rates Following Fission
and Asymptotic Periods Following Reactivity Steps from Equilibrium
Calculated with R(t) Functions Fit to Measurements and Summation Calculations^a (Continued)

System	Pulse Function	# Gp	R(t) Value at t After Fission, fraction/sec					Period T (sec) Following Step			
			t=.05s	t=.50s	t=5.0s	t=50s	t=500s	$\rho=10^6$	$\rho=25^6$	$\rho=40^6$	$\rho=50^6$
²³⁹ PU(H)	This Calc., Free λ_s	6	4.33E-01	2.58E-01	4.66E-02	1.37E-03	1.01E-06	94.21	26.95	12.95	8.98
	, Fixed λ_s	8	4.34E-01	2.57E-01	4.67E-02	1.37E-03	1.00E-06	94.64	27.01	12.97	8.99
	Brady&England'89	6	3.83E-01	2.49E-01	4.38E-02	1.62E-03	1.38E-06	110.83	31.11	14.53	9.89
	Maksyutenko'63	6	3.64E-01	2.49E-01	4.51E-02	1.65E-03	1.24E-06	107.91	31.37	14.86	10.17
	" w/ Ref $\bar{\nu}$ & β							111.72	31.59	14.78	10.06
²⁴⁰ PU(T)	This Calc., Free λ_s	6	3.85E-01	2.33E-01	4.31E-02	2.03E-03	4.69E-07	107.84	29.01	12.03	7.38
	, Fixed λ_s	8	3.86E-01	2.32E-01	4.31E-02	2.04E-03	4.68E-07	107.53	28.98	12.02	7.38
²⁴⁰ PU(F)	This Calc., Free λ_s	6	3.89E-01	2.36E-01	4.37E-02	1.92E-03	5.09E-07	104.42	27.98	11.66	7.21
	, Fixed λ_s	8	3.90E-01	2.35E-01	4.37E-02	1.93E-03	5.08E-07	106.00	28.18	11.71	7.23
	Brady&England'89	6	4.04E-01	2.46E-01	4.12E-02	1.95E-03	5.53E-07	107.16	28.21	11.58	7.10
	Keepin+'57	6	4.07E-01	2.35E-01	4.31E-02	2.01E-03	5.62E-07	107.12	29.12	12.22	7.57
	" w/ Ref $\bar{\nu}$ & β							109.07	29.15	12.09	7.42
	Benedetti+'82	5	2.51E-01	2.01E-01	4.55E-02	2.18E-03	6.38E-07	117.24	32.77	14.04	8.75
	" w/ Ref $\bar{\nu}$ & β							119.38	32.84	13.92	8.61
	Gudkov+'89	6	4.41E-01	2.57E-01	4.31E-02	1.69E-03	5.88E-07	94.56	25.30	10.71	6.73
	" w/ Ref $\bar{\nu}$ & β							96.23	25.29	10.57	6.58
²⁴⁰ PU(H)	This Calc., Free λ_s	6	4.57E-01	2.64E-01	4.51E-02	1.40E-03	8.19E-07	90.04	24.90	11.49	7.76
	, Fixed λ_s	8	4.58E-01	2.63E-01	4.52E-02	1.41E-03	8.16E-07	91.77	25.11	11.54	7.78
	Brady&England'89	6	4.14E-01	2.59E-01	4.32E-02	1.56E-03	1.04E-06	101.97	27.55	12.42	8.27
²⁴¹ PU(T)	This Calc., Free λ_s	6	4.19E-01	2.48E-01	4.26E-02	1.83E-03	3.07E-07	95.94	25.16	10.17	6.11
	, Fixed λ_s	8	4.19E-01	2.48E-01	4.26E-02	1.84E-03	3.07E-07	95.99	25.17	10.17	6.12
	Brady&England'89	6	4.49E-01	2.61E-01	4.08E-02	1.78E-03	2.45E-07	92.66	24.03	9.62	5.77
	Cox'61	5	4.41E-01	2.78E-01	4.19E-02	1.67E-03	2.08E-07	87.56	23.11	9.55	5.90
	" w/ Ref $\bar{\nu}$ & β							87.13	22.61	9.13	5.51
	Waldo+'81	6	3.73E-01	2.77E-01	3.88E-02	1.62E-03	2.51E-07	84.78	22.24	9.22	5.73
	" w/ Ref $\bar{\nu}$ & β							84.32	21.73	8.80	5.35
²⁴¹ PU(F)	This Calc., Free λ_s	6	4.49E-01	2.57E-01	4.22E-02	1.77E-03	3.35E-07	92.91	24.13	9.71	5.84
	, Fixed λ_s	8	4.49E-01	2.56E-01	4.22E-02	1.78E-03	3.34E-07	92.59	24.09	9.70	5.84
	Brady&England'89	6	4.70E-01	2.71E-01	4.06E-02	1.67E-03	2.75E-07	87.39	22.44	8.99	5.42
	Benedetti+'82	5	3.75E-01	2.63E-01	4.29E-02	1.69E-03	3.77E-07	89.31	23.77	9.92	6.16
	" w/ Ref $\bar{\nu}$ & β							88.57	23.24	9.49	5.77
	Gudkov+'89	6	4.62E-01	2.75E-01	4.12E-02	1.62E-03	4.30E-07	88.39	23.47	9.91	6.24
	" w/ Ref $\bar{\nu}$ & β							86.49	22.30	9.00	5.44
²⁴² PU(T)	This Calc., Free λ_s	6	5.29E-01	2.86E-01	4.00E-02	1.55E-03	2.14E-07	79.95	20.11	7.96	4.77
	, Fixed λ_s	8	5.29E-01	2.86E-01	4.01E-02	1.56E-03	2.14E-07	79.87	20.11	7.96	4.77
²⁴² PU(F)	This Calc., Free λ_s	6	5.55E-01	2.95E-01	4.10E-02	1.33E-03	2.21E-07	71.29	17.99	7.29	4.44
	, Fixed λ_s	8	5.55E-01	2.94E-01	4.10E-02	1.34E-03	2.20E-07	71.46	18.01	7.30	4.45
	Brady&England'89	6	4.90E-01	2.76E-01	3.91E-02	1.72E-03	2.99E-07	88.27	22.24	8.69	5.15
	Waldo+'81	6	6.98E-01	3.40E-01	3.63E-02	1.36E-03	1.88E-07	70.52	17.72	7.20	4.46
²⁴² PU(H)	This Calc., Free λ_s	6	5.85E-01	3.05E-01	4.15E-02	1.17E-03	3.54E-07	68.88	18.17	8.04	5.28
	, Fixed λ_s	8	5.86E-01	3.04E-01	4.15E-02	1.18E-03	3.53E-07	69.96	18.30	8.08	5.30
	Auguston+'69	6	6.09E-01	3.07E-01	4.00E-02	1.28E-03	4.68E-07	80.70	23.84	11.64	8.15
	" w/ Ref $\bar{\nu}$ & β							75.13	19.48	8.43	5.46
	East+'69	6	6.02E-01	3.07E-01	4.03E-02	1.27E-03	5.29E-07	80.62	23.82	11.64	8.16
	" w/ Ref $\bar{\nu}$ & β							75.04	19.47	8.44	5.47
²⁴¹ AM(T)	This Calc., Free λ_s	6	3.15E-01	2.05E-01	4.42E-02	2.30E-03	5.82E-07	128.17	36.71	16.36	10.58
	, Fixed λ_s	8	3.15E-01	2.04E-01	4.42E-02	2.31E-03	5.80E-07	130.38	36.99	16.43	10.61
	Brady&England'89	6	3.78E-01	2.40E-01	4.04E-02	2.11E-03	5.27E-07	119.92	33.32	14.64	9.46
	Waldo+'81	5	3.50E-01	2.10E-01	4.39E-02	2.19E-03	8.07E-07	120.22	32.62	13.46	8.15
	" w/ Ref $\bar{\nu}$ & β							128.98	36.15	15.99	10.33
	Saleh+'95	5	2.27E-01	1.82E-01	4.53E-02	2.38E-03	1.02E-06	130.29	36.99	15.96	9.91
	" w/ Ref $\bar{\nu}$ & β							138.02	39.85	17.98	11.66
²⁴¹ AM(F)	This Calc., Free λ_s	6	2.79E-01	1.91E-01	4.49E-02	2.43E-03	8.50E-07	137.81	39.50	17.61	11.36
	, Fixed λ_s	8	2.79E-01	1.90E-01	4.49E-02	2.44E-03	8.48E-07	135.55	39.23	17.54	11.33
	Brady&England'89	6	3.69E-01	2.37E-01	4.22E-02	1.98E-03	6.13E-07	112.93	31.92	14.26	9.32
	Benedetti+'82	5	2.26E-01	1.82E-01	4.63E-02	2.35E-03	1.37E-06	132.36	36.55	15.35	9.38
	" w/ Ref $\bar{\nu}$ & β							137.85	39.72	17.82	11.56
	Gudkov+'89	6	4.03E-01	2.35E-01	4.19E-02	2.04E-03	9.57E-07	113.96	30.97	12.97	7.99
	" w/ Ref $\bar{\nu}$ & β							118.54	33.59	14.98	9.74
²⁴¹ AM(H)	This Calc., Free λ_s	6	3.99E-01	2.50E-01	4.58E-02	1.49E-03	1.12E-06	113.40	34.42	17.41	12.44
	, Fixed λ_s	8	4.00E-01	2.49E-01	4.58E-02	1.50E-03	1.12E-06	118.82	35.04	17.57	12.53
^{242m} AM(T)	Brady&England'89	6	4.05E-01	2.51E-01	4.31E-02	1.62E-03	1.51E-06	129.70	37.46	18.44	13.01
	This Calc., Free λ_s	6	3.65E-01	2.23E-01	4.36E-02	2.10E-03	4.33E-07	113.71	31.40	13.45	8.46
	, Fixed λ_s	8	3.66E-01	2.23E-01	4.36E-02	2.11E-03	4.32E-07	111.41	31.13	13.38	8.43
	Brady&England'89	6	3.89E-01	2.43E-01	4.14E-02	2.00E-03	3.93E-07	106.08	29.24	12.48	7.86
	Waldo+'81	6	2.71E-01	2.08E-01	4.45E-02	2.18E-03	5.63E-07	115.83	31.89	13.34	8.16
	" w/ Ref $\bar{\nu}$ & β							116.84	33.05	14.34	9.06

Table 11. Comparison of Relative Delayed-Neutron Production Rates Following Fission
and Asymptotic Periods Following Reactivity Steps from Equilibrium
Calculated with R(t) Functions Fit to Measurements and Summation Calculations^a (Continued)

System	Pulse Function	# Gp	R(t) Value at t After Fission, fraction/sec					Period T (sec) Following Step			
			t=.05s	t=.50s	t=5.0s	t=50s	t=500s	$\rho=10\ell$	$\rho=25\ell$	$\rho=40\ell$	$\rho=50\ell$
²⁴³ AM(F)	This Calc., Free λ_s	6	4.02E-01	2.36E-01	4.29E-02	1.99E-03	4.03E-07	106.93	29.05	12.28	7.69
	, Fixed λ_s	8	4.03E-01	2.36E-01	4.30E-02	2.00E-03	4.02E-07	107.49	29.13	12.30	7.70
	Brady&England'89	6	3.76E-01	2.34E-01	4.07E-02	2.20E-03	3.73E-07	116.72	31.91	13.39	8.28
	Charlton'97 " w/ Ref $\bar{\nu}$ & β	6	3.55E-01	2.44E-01	4.32E-02	1.89E-03	4.25E-07	102.07	27.77	11.74	7.33
	Charlton+'98 " w/ Ref $\bar{\nu}$ & β	7	3.34E-01	2.27E-01	4.27E-02	2.14E-03	4.19E-07	110.72	30.37	12.74	7.88
								112.80	30.93	13.10	8.17
²⁴² CM(F)	This Calc., Free λ_s	6	2.66E-01	1.85E-01	4.43E-02	2.59E-03	1.33E-06	171.19	53.34	26.54	18.57
	, Fixed λ_s	8	2.67E-01	1.84E-01	4.42E-02	2.59E-03	1.33E-06	191.86	55.76	27.20	18.89
Brady&England'89	6	3.24E-01	2.20E-01	3.92E-02	2.44E-03	1.49E-06	186.91	53.48	25.86	17.93	
²⁴³ CM(T)	This Calc., Free λ_s	6	4.07E-01	2.35E-01	4.32E-02	2.00E-03	6.91E-07	119.29	34.27	15.82	10.62
	, Fixed λ_s	8	4.07E-01	2.34E-01	4.32E-02	2.01E-03	6.88E-07	123.02	34.72	15.94	10.68
²⁴³ CM(F)	This Calc., Free λ_s	6	2.87E-01	1.92E-01	4.45E-02	2.43E-03	9.83E-07	143.98	42.22	19.48	12.93
	, Fixed λ_s	8	2.87E-01	1.91E-01	4.46E-02	2.44E-03	9.80E-07	152.86	43.29	19.77	13.07
²⁴⁴ CM(S)	This Calc., Free λ_s	6	2.14E-01	1.54E-01	3.98E-02	3.44E-03	3.12E-07	174.95	52.60	23.57	14.79
	, Fixed λ_s	8	2.15E-01	1.53E-01	3.96E-02	3.46E-03	3.13E-07	170.70	52.06	23.42	14.72
²⁴⁴ CM(F)	This Calc., Free λ_s	6	3.36E-01	2.12E-01	4.40E-02	2.23E-03	5.91E-07	126.13	35.97	16.10	10.48
	, Fixed λ_s	8	3.37E-01	2.11E-01	4.40E-02	2.24E-03	5.90E-07	120.73	35.31	15.92	10.39
²⁴⁵ CM(T)	This Calc., Free λ_s	6	4.98E-01	2.80E-01	4.40E-02	1.25E-03	3.76E-07	77.75	21.49	9.84	6.58
	, Fixed λ_s	8	4.99E-01	2.79E-01	4.39E-02	1.26E-03	3.75E-07	80.01	21.75	9.90	6.62
Brady&England'89	6	4.33E-01	2.71E-01	4.32E-02	1.40E-03	3.67E-07	87.19	23.66	10.64	7.04	
²⁴⁶ CM(S)	Waldo+'81 " w/ Ref $\bar{\nu}$ & β	6	2.75E-01	2.09E-01	4.39E-02	2.23E-03	4.00E-07	116.65	32.20	13.45	8.20
								124.94	34.93	15.30	9.78
²⁴⁶ CM(F)	This Calc., Free λ_s	6	3.42E-01	2.14E-01	4.11E-02	2.46E-03	2.21E-07	126.31	35.48	15.04	9.29
	, Fixed λ_s	8	3.42E-01	2.14E-01	4.11E-02	2.48E-03	2.21E-07	128.90	35.80	15.12	9.32
²⁴⁶ CM(F)	This Calc., Free λ_s	6	4.56E-01	2.56E-01	4.17E-02	1.80E-03	2.35E-07	96.31	25.85	10.90	6.84
	, Fixed λ_s	8	4.57E-01	2.56E-01	4.17E-02	1.82E-03	2.34E-07	96.37	25.86	10.90	6.84
²⁴⁸ CM(S)	This Calc., Free λ_s	6	4.52E-01	2.71E-01	4.02E-02	1.71E-03	8.01E-08	87.75	22.79	9.19	5.57
	, Fixed λ_s	8	4.52E-01	2.71E-01	4.00E-02	1.72E-03	8.01E-08	87.41	22.74	9.18	5.57
²⁴⁸ CM(F)	This Calc., Free λ_s	6	5.99E-01	3.13E-01	3.79E-02	1.34E-03	8.46E-08	69.69	17.41	7.03	4.31
	, Fixed λ_s	8	5.99E-01	3.13E-01	3.79E-02	1.35E-03	8.46E-08	69.14	17.35	7.02	4.30
²⁴⁹ CF(T)	This Calc., Free λ_s	6	4.36E-01	2.43E-01	3.88E-02	2.28E-03	5.52E-07	131.20	38.52	17.97	12.12
	, Fixed λ_s	8	4.36E-01	2.43E-01	3.88E-02	2.30E-03	5.51E-07	122.37	37.40	17.67	11.97
Brady&England'89	6	2.92E-01	2.00E-01	3.82E-02	2.89E-03	3.94E-07	148.79	46.91	22.26	14.89	
²⁵⁰ CF(S)	Waldo+'81 " w/ Ref $\bar{\nu}$ & β	4	1.99E-01	1.67E-01	4.58E-02	2.56E-03	6.01E-07	135.57	38.59	16.48	10.10
								140.56	44.56	21.56	14.67
²⁵¹ CF(T)	This Calc., Free λ_s	6	3.21E-01	2.07E-01	4.12E-02	2.56E-03	3.00E-07	136.25	39.64	17.66	11.35
	, Fixed λ_s	8	3.23E-01	2.05E-01	4.10E-02	2.58E-03	3.01E-07	137.53	39.81	17.71	11.37
²⁵² CF(S)	This Calc., Free λ_s	6	3.92E-01	2.37E-01	3.95E-02	2.25E-03	5.49E-08	116.13	32.47	13.91	8.74
	, Fixed λ_s	8	3.92E-01	2.36E-01	3.93E-02	2.27E-03	5.50E-08	116.95	32.57	13.93	8.75
Brady&England'89	6	3.14E-01	2.15E-01	3.90E-02	2.57E-03	3.94E-08	132.32	37.75	16.29	10.16	
²⁵³ ES(S)	This Calc., Free λ_s	6	5.39E-01	2.92E-01	3.93E-02	1.50E-03	1.69E-07	81.66	21.86	9.53	6.20
	, Fixed λ_s	8	5.38E-01	2.92E-01	3.93E-02	1.51E-03	1.68E-07	82.19	21.92	9.55	6.21
Brady&England'89	6	3.20E-01	2.19E-01	4.15E-02	2.25E-03	1.92E-07	120.25	33.84	14.62	9.20	
Smith+'58 " w/ Ref $\bar{\nu}$ & β	3	6.50E-01	3.89E-01	2.87E-02	1.56E-03	2.63E-10	74.33	19.54	8.65	5.79	
²⁵⁴ ES(T)	Chulick+'69 " w/ Ref $\bar{\nu}$ & β	4	3.55E-01	2.37E-01	3.98E-02	2.29E-03	1.94E-08	130.50	36.43	15.90	10.16
								124.72	34.57	14.66	9.12
²⁵⁴ ES(T)	This Calc., Free λ_s	6	3.80E-01	2.27E-01	4.13E-02	2.27E-03	2.73E-07	126.59	37.05	17.08	11.38
	, Fixed λ_s	8	3.80E-01	2.26E-01	4.12E-02	2.29E-03	2.73E-07	120.56	36.29	16.87	11.28
²⁵⁴ FM(S)	This Calc., Free λ_s	6	4.22E-01	2.47E-01	3.90E-02	2.15E-03	1.55E-08	111.66	31.39	13.70	8.78
	, Fixed λ_s	8	4.22E-01	2.47E-01	3.88E-02	2.16E-03	1.56E-08	112.62	31.50	13.72	8.79
Brady&England'89	6	3.77E-01	2.41E-01	3.83E-02	2.28E-03	1.35E-08	119.17	33.65	14.66	9.34	
²⁵⁵ FM(T)	This Calc., Free λ_s	6	2.41E-01	1.63E-01	3.88E-02	3.39E-03	1.40E-07	194.75	63.21	31.93	22.28
	, Fixed λ_s	8	2.41E-01	1.63E-01	3.87E-02	3.42E-03	1.40E-07	224.57	66.78	32.94	22.78
²⁵⁶ FM(S)	This Calc., Free λ_s	6	1.94E-01	1.49E-01	3.99E-02	3.40E-03	3.76E-08	171.67	52.18	23.68	15.00
	, Fixed λ_s	8	1.95E-01	1.49E-01	3.97E-02	3.43E-03	3.77E-08	173.07	52.38	23.73	15.01
Brady&England'89	6	2.31E-01	1.61E-01	3.74E-02	3.47E-03	6.01E-08	174.98	52.83	23.80	14.97	
²⁵⁶ FM(S)	This Calc., Free λ_s	6	2.83E-01	1.92E-01	3.98E-02	2.87E-03	9.14E-08	151.76	45.62	21.01	13.75
	, Fixed λ_s	8	2.83E-01	1.92E-01	3.96E-02	2.89E-03	9.16E-08	159.14	46.55	21.26	13.87

a) Values, such as 1.86-1, are to be read as 1.86×10^{-1} . Unless otherwise noted, results for pulse functions obtained from measurements use $\bar{\nu}$ & β associated with the measurement.